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Alaska Department of Fish and Game
Commercial Fisheries Management
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P.O. Box 25526
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An Estimation of Juvenile Fish Densities in Skilak and Kenai Lakes, Alaska, Through the Use of Dual-Beam Hydroacoustic Techniques in 1992

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State of Alaska Walter J. Hickel, Governor

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ABSTRACT

The number and distribution of sockeye salmon *Onchorhynchus nerka* rearing in two glacial lakes of the Kenai River drainage was estimated in 1992 from hydroacoustic surveys. Using dual-beam acoustic techniques, mean *in situ* target strength measurements ranged from -53.1 dB to -54.6 dB. Densities of fish estimated in May suggested a significant over-winter mortality of age-0 sockeye salmon. Surviving fish were concentrated at 37–42 m in May and showed indications of moving toward the surface with increasing darkness. This pattern was partially reversed in the fall when densities were higher in the surface waters during the day and deeper at night. In October the number of age-0 sockeye salmon in Kenai and Skilak Lakes was estimated at 9,506,000. A linear relationship between potential spawners and fall fry numbers was found. Age-0 sockeye salmon mean length and weight increased by 5 mm and 0.1 g between September and December 1992.

KEY WORDS: hydroacoustic survey, sockeye salmon, target strength, glacial lake, Alaska, *Onchorhynchus nerka*

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) began investigations in 1972 to assess juvenile sockeye salmon *Onchorhynchus nerka* populations rearing in the major lakes of the Kenai River drainage (Figure 1; Davis et al. 1973). As part of these investigations, juvenile sockeye salmon were collected from Skilak and Kenai Lakes using tow nets to estimate relative abundance, age structure, and growth (Davis et al. 1974; Namtvedt and Friese 1976). However, the inefficiency of tow netting restricted the usefulness of these data for abundance estimates (Waltemyer 1981). Therefore, in 1986 ADF&G began developing new methods to enumerate fry using hydroacoustic equipment (Tarbox and King 1988a, 1988b).

Annual fall hydroacoustic surveys have been conducted in Kenai and Skilak Lakes since 1986 to develop a time series of juvenile sockeye salmon population estimates. Program objectives for the 1992 field investigation were to (1) estimate the number and spatial distribution of sockeye salmon juveniles, (2) determine the target strength distributions using dual-beam hydroacoustic techniques, (3) document the condition of juvenile sockeye salmon using length and weight measurements, and (4) estimate the age composition of sockeye salmon in each lake.

In addition, 1992 studies are part of an ongoing project, Exxon Valdez Oil Spill (EVOS) Restoration Project 93002, to assess the impacts on freshwater production of relatively large adult sockeye escapements into the Kenai River drainage. Starting in 1987 and continuing through 1989, the Kenai River system received spawning escapements in excess of 1.0 million sockeye salmon, well above the desired escapement goal range of 400,000–700,000 sockeye. These large escapements were the result of ADF&G management decisions associated with the Glacier Bay oil spill in 1987 and the Exxon Valdez oil spill in 1989. Reduced fishing opportunities on Kenai River stocks in the mixed stock fishery were effected in 1988 to protect weaker non-Kenai stocks.

Since the initiation of the project in 1986 the standard procedure for estimating juvenile sockeye salmon abundance in Kenai and Skilak Lakes has been to conduct night-time hydroacoustic surveys during September or October. While this procedure was followed in 1992, we also conducted hydroacoustic work in Skilak Lake during May and during daylight in mid-October. The objective of these supplemental studies was to define the depth distribution of rearing sockeye salmon in spring and fall.

METHODS

October Night Survey

We used a stratified random sampling design for 1992 fall night surveys to distribute sampling effort and provide an acceptable way of calculating sampling error. We divided each lake into areas or sub-basins and randomly established survey transects within each of these areas. In 1992 the number of transects was chosen to reduce the relative error to 0.25 for Skilak Lake and 0.3 for Kenai Lake. Our sample size was based on the average coefficient of variation observed from 1986 to 1989. Because of the configuration of Skilak Lake, a total of 13 transects perpendicular to shore were surveyed within three sub-basins (Figure 2). In Kenai Lake a total of 27 transects were surveyed within five sub-basins (Figure 3). The Kenai Lake survey was conducted on 7 October and the Skilak Lake survey on 2 October 1992.

The equipment used for data acquisition consisted of a Biosonics Inc. Model 105[1] echo sounder with dual-beam receivers, a 420 kHz 6°/15° dual beam transducer mounted in a V-fin for towing, a Model 171 tape recorder interface, a Sony[1] digital audio tape (DAT) player, a chart recorder, and an oscilloscope. The selected pulse width was 0.4 ms and the pulse repetition rate was 5 pulses/s. Additional acoustic parameters used during data collection and processing are presented in Appendix A.1. Biosonics, Inc. calibrated the system before and following the surveys. The entire system was powered by 12-V batteries and carried in a 7.2-m vessel powered by outboard motors. Vessel speed along each transect was estimated at 2.0 to 2.5 m/s. The transducer was towed approximately 1 m below the water surface during surveys. Equipment procedures were outlined in King and Tarbox (1988).

Dual-beam data recorded on DAT were processed through a Biosonics, Inc. Model 281 Echo Signal Processor[1] (ESP). A returning pulse was accepted as a valid target if the amplitude was below the bottom threshold of 7000 mV and above the counting threshold of 200 mV. Single targets were separated from multiple targets if the pulse width was within 20% of the transmitted pulse width at -6 dB and -18 dB. The maximum half-angle selected for data processing was 4°. Data were stratified in 5-m increments for analysis starting 2 m below the transducer, or 3 m below the water surface. Only data collected at range less than 97 m were accepted for processing. Examination of oscilloscope traces and echograms indicated that few fish were present below this depth.

Data generated by the dual beam processor were transferred to computer data files for analysis using the Biosonics, Inc. software "Target Strength Post Processing Program ESPTS." Computations of mean target strength and backscattering cross section were made from individual echoes, and a hard copy of the results was printed for each 5-m depth interval.

Estimates of fish density were made for each transect by echo integration using a Biosonics, Inc. ESP Model 221[1] echo integrator. Correction from the 40 log(R) setting used during data collection to the 20 log(R) used for data processing was accomplished by adjusting the B constant value for each depth stratum (Appendix A.1).

The echo integrator compiled data in 1-min sequences along each transect and sent outputs to computer files for further reduction and analysis using the Biosonics, Inc. software "Echo Integration Post Processing Program ESPCRNCH." Raw integrator outputs were edited to remove data that resulted from false bottom echoes. Where this occurred, fish densities were usually estimated using the average densities of adjacent sequences at the same depth. Overall fish density was obtained by calculating the average edited integrator output value across the transect for each depth stratum. These averages were multiplied by the integrator scaling factor derived from the mean backscattering cross-section value obtained from the ESPTS program. Mean backscattering cross section values were calculated for each depth stratum using data from those transects where false bottom did not occur or did not influence the target strength data.

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[1] Use of a company name does not constitute endorsement by ADF&G.

The total number of fish (N_{ij}) for area stratum i based on transect j was estimated across depth stratum k. It consisted of the number of fish estimated by hydroacoustic gear in the midwater section (M_{ij}) plus an estimate of fish unavailable to the hydroacoustic gear because of their location near the surface (S_{ij}) or bottom (B_{ij}), or

$$N_{ij} = S_{ij} + M_{ij} + B_{ij} \ .$$

The midwater component was estimated as

$$M_{ij} = \sum_{k=1}^{K} a_i w_{ijk} m_{ijk} \ ,$$

where a_i represented the surface area (m^2) of area stratum i which was estimated using a planimeter and USGS maps of Skilak and Kenai Lakes, and w_{ijk} was the average depth (5m) of depth stratum k measured along transect j in area i. This depth would be less than the maximum 5 m if the bottom was detected within depth stratum k anytime along the transect. The mean fish density in area i depth k across transect j was m_{ijk} in number per m^3.

The estimated number of fish near the surface (0-3 m) in area i was

$$S_{ij} = a_{is} m_{ij1} \ ,$$

where a_{is} was the estimated volume (m^3) of the surface area stratum (0-3 m), and m_{ij1} was the mean fish density for the first ensonified depth strata (2-7 m below transducer) of transect j.

The estimated number of fish near the bottom was

$$B_{ij} = \sum_{k=1}^{K} b_{ijk} m_{ijk} \ ,$$

where b_{ijk} was the estimated volume (m^3) in area i of depth k that could not be ensonified due to the proximity of the bottom along transect j, and m_{ijk} was the estimated fish density (number per m^3) along transect j in area i depth k that was ensonified. In cases where all of depth stratum k was along the bottom, the mean density m_{ijk-1} from the next shallower depth strata (k-1) was used.

The abundance in area i (N_i) became the mean abundance estimated by each transect j, or

$$N_i = J^{-1}\sum_{j=1}^{J} N_{ij} ,$$

and its variance was estimated as

$$V(N_i) = \sum_{j=1}^{J} (N_{ij} - N_i)^2 (J-1)^{-1} J^{-1} .$$

Total abundance for each lake became the sum of its area estimates. Its variance became the sum of the area variances.

To estimate species composition, daylight midwater trawling was conducted in Skilak Lake on 22 and 23 September. A similar program was conducted in Kenai Lake between 9 and 18 September. A total of 427 min was spent towing in Skilak Lake and 608 min in Kenai Lake. The trawl mouth opening was 6.1 m by 3.1 m, and trawl length was 14.9 m. Mesh size decreased from 7.62 cm at the mouth to 0.32 cm at the cod end. The gear was towed between two boats at approximately 2 m/s, and the majority of the tows were near the surface. The sampling program was designed to collect a minimum of 300 fish from each area of each lake. All captured fish were enumerated, identified, and preserved in 10% formalin. In the laboratory juvenile sockeye salmon were measured to the nearest millimeter (fork length), weighed to the nearest 0.1 g, and an age determined from scale samples using criteria outlined by Mosher (1969). Differences in age and species composition between areas were tested with chi-square analysis.

Age-specific estimates of the numbers of juvenile sockeye salmon (N_{ayi}) were estimated

$$N_{ayi} = N_{yi}\, p_{ayi},$$

where p_{ayi} was the proportion of fish caught in area i (n_{yi}) and year y of age a (n_{ayi}). Samples were pooled across areas not found to have significantly different age compositions (chi-square test). The pooled proportion for age a was then substituted for p_{ayi} for the appropriate areas.

The variance for N_{ayi} was estimated as the product of two random variables, p_{ayi} and N_{yi}, as

$$V(N_{ayi}) = N_{yi}^2 V(p_{ayi}) + p_{ayi}^2 V(N_{yi}) - V(p_{ayi}) V(N_{yi}).$$

The total estimate for the Kenai and Skilak Lakes system became

$$N_{ay} = \sum_{all\ i} N_{ayi},$$

and its variance was estimated as

$$V(N_{ay}) = \sum_{all\ i} V(N_{ayi}) \quad .$$

Supplemental Studies

Between 8–11 May we tow-netted several areas of Skilak Lake (11 tows, 330 min; Figure 4). Because we failed to capture fish, we used the hydroacoustic gear during daylight of 14 May to define fish abundance and depth distribution, primarily in Area 1, of Skilak Lake (Figure 5). A second survey was conducted on 20 May to define diel vertical behavior of juvenile sockeye salmon. A single transect in Area 1 of Skilak Lake was replicated six times in a 6-h period (1842 to 0008 hours). In addition, four other transects were completed between 1900 and 2140 hours to look for concentrations of fish (Figure 6). Hydroacoustic parameters used during the May surveys are presented in Appendix A.1. Because of low densities of fish in the study area, mean target strength data by depth were calculated by pooling results from the two surveys.

Following the regular night hydroacoustic survey of Skilak Lake on 2 October, we returned to the lake on 13 October to ascertain the vertical distribution of juvenile fish abundance during the day. A total of five transects was completed in Area 1 (Figure 7).

In both the May and October hydroacoustic work we processed data with the same equipment used for the October night survey. Data analysis procedures were also the same, except that no estimates of surface or bottom population numbers were made.

We also supplemented the Skilak Lake tow netting work in October with efforts on 2 November and 3 December (Figure 4). Nine tows totaling 315 min were made in November and 6 tows totaling 180 min were made in December. Sample handling and processing were the same as in October.

RESULTS

May Hydroacoustic and Tow Net Survey

A total of three fish was captured during the tow-netting operation: a juvenile sockeye salmon, a Dolly Varden *Salvelinus malma*, and a threespine stickleback *Gasterosteus aculeatus*. Hydroacoustic estimates of fish density indicated that few fish were available to the tow nets. Maximum density of fish measured on 14 May was 0.0017 fish/m^3 (Figure 8). Low fish density in the tow net area was confirmed on 20 May when maximum densities were 0.0009 fish/m^3 (Figure 9). Population estimates for Area 1 ranged from 8,830 to 221,100 fish on 14 May (Table 1). Similar estimates were also made for 20 May, although geographic coverage was more limited.

In four of the six transects conducted on 14 May, peak fish densities were measured between 37–42 m (Figure 8). The remaining two transects had densities peaking between 27–37 m. This pattern — most fish deep below the surface during the day — was also observed in the early transects conducted on 20 May when maximum fish densities were at 32–37 m at 1842 hours. However, fish appeared to be moving toward the surface with approaching darkness. Maximum densities recorded at 2052 hours were at 27–32 m. By 2308 hours maximum densities were at 7–12 m (Figure 9). Near midnight the distribution of fish appeared to be more uniform in the water column, but this is probably an artifact of fish not being available to the hydroacoustic gear when they are near the surface. Fish numbers decreased by half when fish appeared to enter the surface waters above the transducer (Table 1). Low densities of fish were also observed on the echograms from transects 1.2, 1.3, 1.5, and 1.6.

Mean target strength was measured at -54.6 dB (Appendix A.2) which was within historical range of values measured for Skilak Lake.

October Night Hydroacoustic and Day Tow Net Survey

A total of 7,491 echoes in Kenai Lake and 34,192 in Skilak Lake were used to estimate target-strength distributions. Mean target strength for Kenai Lake was -53.8 dB (Appendix A.3). As in past years, calculated mean target strengths decreased with depth. Near-surface measurements were -51.4 dB in contrast to -55.0 dB at a depth of 42–47 m. In Skilak Lake the mean target strength was -53.4 dB. Mean target strength decreased from a near surface value of -50.2 dB to -55.1 dB at 47 m (Appendix A.4). Mean target strength measured on 13 October was -53.1 dB, similar to the mean for September (Appendix A.5).

Estimates of fish abundance in surface (Appendix A.6) and bottom strata (Appendices A.7, A.8) that were not sampled by the hydroacoustic gear contributed a maximum of 38% to an individual transect estimate (Kenai Lake, Area 1, Transect 1). Overall, the surface estimate was 8% and the bottom estimate 4% of the total.

The total estimated number of fish in both lakes was 9,635,300 (Table 2). Approximately 12%, or 1,126,400 fish, were found in Kenai Lake and the remaining 8,508,900 fish in Skilak Lake. Approximately 66.5% of the fish in Skilak Lake were located in Area 1, which comprised 38.3% of the lake volume (Table 3). Within Kenai Lake 34.9% of the fish were located in Area 1, which composed 5.3% of the lake volume.

The maximum fish density observed in Skilak Lake was 0.0178 fish/m^3 between 22–27 m along Transect 6 of Area 1 (Figure 10). Maximum densities of fish were recorded in the 17–22 m depth range for 5 of the 13 transects (Figures 10, 11). Four transects had maximum densities deeper in the water column and four shallower.

The maximum density of fish observed in Kenai Lake was 0.0112 fish/m^3 between 2 and 7 m along Transect 1 of Area 1. The maximum density of fish observed varied from the 2–7 m strata to the 37–42 m strata along the remaining transects. Seven transects had maximum densities at the 2–7 m strata.

A total of 1,410 fish were captured during tow netting operations in Skilak Lake and 1,834 in Kenai Lake. Sockeye salmon were the predominant species in catches from both lakes, representing nearly 100% of the total catch for both lakes (Table 4). Other than sockeye salmon only four coho salmon *Oncorhynchus kisutch* were captured in Skilak Lake. In Kenai Lake two Dolly Varden and three coho salmon were captured.

Age-1 sockeye salmon made up 0.8% and age-0 composed 99.2% of the Kenai Lake juvenile sockeye estimate (N = 1,504; Table 4). Within Skilak Lake, age-0 sockeye salmon comprised 98.9% of the estimate (N = 893; Table 4). No difference between sampling areas was observed in either lake (chi-square = 2.32 , P= .05, df = 2 for Skilak Lake, chi-square = 1.48, P=.05, df=4 for Kenai Lake).

After adjusting the total number of targets using species and age composition data from trawl samples, the number of juvenile sockeye salmon in both lakes was estimated at 9,608,300. Of this total, 9,506,000 were age-0 sockeye salmon produced by the 1991 spawning population, and 102,300 were age-1 sockeye salmon produced by the 1990 spawning population (Table 4).

Mean length of age-0 sockeye salmon in Skilak Lake was 54 mm and mean weight was 1.7 g. Age-1 sockeye in Skilak Lake had a mean length of 89 mm and weight of 7.0 g. Mean size of age-0 sockeye in Kenai Lake was 56 mm and 2.0 g were larger (N.S.C.) in size than those collected in Skilak Lake (Table 5).

October Day Hydroacoustic Survey

Fish density on 13 October was distributed in a bimodal pattern. Highest fish densities were observed near surface and below 12 m, resulting in two layers of fish separated by a 5 m strata where densities were lower. All five transects indicated increasing fish densities at the 2–7 m depth zone. However, peak densities were measured below 12 m in three of the five transects (Figure 12). Numbers of fish estimated for Area 1 (mid-water) ranged from 1.8 to 5.2 million fish, which differs slightly from the 2.4 to 7.6 million fish estimated on 2 October.

November/December Tow Net

Age-0 sockeye salmon captured on 2 November in Skilak Lake had a mean length of 57 mm and weight of 1.8 g (N = 858; Table 5). One month later on 3 December, they were 59 mm and 1.8 g (N= 104; Table 5). More than 99% of the fish were age-0.

DISCUSSION

This is the seventh year of hydroacoustic work on Skilak Lake, and during that time several trends have appeared in the data. Fish-target strength estimates by depth in 1992 were within historical bounds (Figure 13), and the trend of decreasing target strength with depth continued. This phenomenon appears related to the use of 420 kHz in this glacial lake system. Tarbox et al. (1993) found no decrease in target strength with depth using a 120 kHz system in Skilak Lake.

The use of *in situ* target strength measurements and echo integration techniques has minimized the influence of decreasing target strengths with depth on the population estimate. In addition, there have been several independent evaluations of the technique. In 1992, a series of hydroacoustic transects on Skilak Lake were completed on 6 August by ADF&G FRED Division, and a mid-water population estimate of 7.38 million fish was made using echo counting techniques (Thorne 1993). In October, we estimated 7.6 million fish in the mid-water portion of the lake. The August survey was conducted in the evening, but effective light reduction, because of latitude, was minimal. Thorne (1993) noted high fish densities in the 2–4 m depth strata that indicated a near surface orientation for some portion of the population. Regardless of this orientation, the estimates were very close, even with anticipated mortality between August and September.

Schmidt et al. (1993) noted a relationship between potential egg deposition (a function of the number of spawners) and fall fry numbers in Skilak and Kenai Lakes over the available time series (Figure 14). Their linear model level had a significant slope (P = 0.05). The constant term was not significantly larger than zero (P = 0.26) and the Durbin-Watson statistic indicated no autocorrelation (P > 0.05). Age-0 fall fry abundance in 1986 (1985 broodyear) had a studentized residual of 4.06 and is, therefore, a possible outlier.

The distribution of fish between Skilak and Kenai Lakes has also been very consistent: Skilak Lake generally produces between 80% and 90% of the counts (Figure 15). The relationship of fall fry numbers to spawners is further supported by this observation. If the number of fall fry is related strictly to egg deposition (spawner distribution), then a consistent relationship between the two lakes would be expected.

Tarbox et al. (1992) noted that the two major Kenai Lake sockeye salmon spawning tributaries accounted for 13% of the escapement. Kyle (ADF&G, Soldotna, personal communication) indicated that Kenai Lake could produce 31% of the total fry production based on euphotic volume measurements. We concluded that the Kenai Lake system has been consistently below this production level because of the distribution of spawners during the study period.

Fish behavior studies in Skilak Lake in the spring gave us a preliminary indication that few fish survived the winter. Area 1, which contributed 47.5% to the population estimate, or 3,186,000 fish the previous fall (Tarbox et al 1993), had densities of one tenth, or less, in the spring. Our initial reaction to these data was that fish may have been in the shallows or near the bottom and therefore unavailable to the gear. However, the diel studies on 20 May indicated no fish movement from bottom areas with the approach of or during darkness. In addition, we had observed fish in the fall in these nearshore areas, making our concern about shallow-water orientation less valid. Further confirmation of low spring fry numbers occurred with the estimate of smolt outmigration. King et al. (1993) estimated only 618,000 sockeye smolt left the Kenai drainage between 15 May and 30 June 1992. No significant holdover was evident in our October 1992 survey because <1% of the estimate was age-1. Therefore, we think a significant overwinter mortality took place in Skilak Lake during the 1991–92 winter. This continues a decreasing trend of smolt production for the drainage since 1989 (Figure 16).

Movement from deeper water areas toward the surface with the approach of darkness is typical behavior for juvenile sockeye salmon in clear water systems. While this pattern was apparent during May surveys, our previous work in the fall had indicated sockeye were more surface oriented during the day. We had hypothesized that juvenile sockeye salmon in glacial systems needed to be surface oriented to feed. We also assumed that feeding took place in the spring before smolt outmigration and that fish would therefore be surface oriented. On 13 October we did observe that densities of fish were higher near the surface during daylight. However, the pattern was less evident than in previous years. These observations suggest an apparent reversal in diel behavior takes place between May and October. This phenomenon needs further documentation before definitive conclusions can be made.

Growth of sockeye salmon in Skilak and Kenai Lakes was better in 1992 than in the previous 4 years. Fall fry weights are nearly double the 1988 measured weight for age-0 sockeye salmon (Table 6) when 37 million fish were in the lakes. This was the first year we were able to collect fish into the winter. Our data indicated that little or no weight gain occurs between September and December (<0.1 g) although fish did increase in length by 5 mm (10% of their body length).

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Table 1. Estimated number of fish available to the hydroacoustic techniques in Skilak Lake, Alaska, daylight surveys May and October 1992.

Date	Area	Transect	Beginning Time	Estimated Number of Fish
May 14, 1992	1	1	0943	8.0756E+04
		2	1023	2.2110E+05
		3	1059	1.9723E+05
		4	1159	1.9840E+05
		5	1340	2.1500E+05
		6	1429	8.8303E+03
May 20, 1992[a]	1	1	1842	1.3611E+05
		4	2052	2.5868E+05
		7	2239	1.6384E+05
		8	2308	1.8944E+05
		9	2338	8.1997E+04
May 21, 1992	1	10	0008	7.3984E+04
Oct.13, 1992	1	1	1007	3.4334E+06
		2	1033	2.1326E+06
		3	1102	3.7937E+06
		4	1133	1.8705E+06
		5	1159	5.2730E+06

[a]Transects 1.9 and 1.10 were completed in darkness.

Table 2. Estimated number of fish in Skilak and Kenai Lakes, Alaska, night survey, 2 and 7 October 1992.

Lake	Area	Transect	Estimated Number of Fish: Surface	Midwater	Bottom	Total	Area Mean	Variance
Skilak	1	1	3.5306E+04	4.0677E+06	2.0012E+05	4.3031E+06		
		2	1.2868E+05	3.6850E+06	2.4535E+05	4.0590E+06		
		3	1.7672E+04	2.4507E+06	1.3370E+05	2.6021E+06	5.6598E+06	9.6964E+11
		4	1.1481E+05	5.9130E+06	4.2152E+05	6.4493E+06		
		5	8.3741E+05	7.6475E+06	5.1545E+05	9.0004E+06		
		6	2.0151E+04	7.1031E+06	4.2173E+05	7.5450E+06		
	2	1	4.5613E+04	1.3698E+06	3.4806E+04	1.4502E+06		
		2	4.4067E+04	2.6073E+06	1.0740E+05	2.7588E+06	2.1012E+06	1.4270E+11
		3	5.4597E+03	1.9981E+06	9.1009E+04	2.0946E+06		
	3	1	2.6737E+05	7.0454E+05	4.8771E+04	1.0207E+06		
		2	1.9508E+05	5.1615E+05	1.3972E+04	7.2520E+05	7.4787E+05	1.1761E+10
		3	1.6949E+05	5.7681E+05	8.6177E+03	7.5492E+05		
		4	1.9886E+04	4.4678E+05	2.4020E+04	4.9069E+05		
	TOTAL						8.5089E+06	1.1241E+12
Kenai	1	1	2.5823E+05	8.9871E+05	3.0244E+05	1.4594E+06		
		2	8.6132E+03	2.7593E+05	8.8018E+04	3.7256E+05		
		3	1.0579E+03	1.3317E+05	4.9476E+04	1.8370E+05	3.9267E+05	3.2401E+10
		4	2.3438E+03	1.3952E+05	2.2218E+04	1.6408E+05		
		5	0.0000E+00	2.1054E+05	2.2816E+04	2.3336E+05		
		6	1.9610E+02	1.4335E+05	1.6101E+04	1.5965E+05		
		7	1.6867E+04	1.4897E+05	1.0107E+04	1.7594E+05		
	2	1	0.0000E+00	3.4080E+05	0.0000E+00	3.4080E+05		
		2	0.0000E+00	2.6694E+05	0.0000E+00	2.6694E+05		
		3	1.1276E+04	2.6937E+05	0.0000E+00	2.8065E+05	3.7399E+05	6.3203E+09
		4	1.2891E+04	5.9470E+05	0.0000E+00	6.0759E+05		
	3	1	0.0000E+00	4.7718E+04	0.0000E+00	4.7718E+04		
		2	5.4861E+03	1.4664E+05	0.0000E+00	1.5213E+05		
		3	1.6202E+03	5.2982E+04	0.0000E+00	5.4602E+04	9.2223E+04	4.2320E+08
		4	0.0000E+00	1.2816E+05	0.0000E+00	1.2816E+05		
		5	3.1652E+03	7.5344E+04	0.0000E+00	7.8509E+04		
	4	1	9.2083E+03	2.6995E+04	0.0000E+00	3.6203E+04		
		2	6.2854E+04	1.6299E+05	0.0000E+00	2.2584E+05		
		3	1.3304E+04	3.5738E+05	0.0000E+00	3.7068E+05	1.8461E+05	3.9411E+09
		4	4.5998E+03	4.7384E+04	0.0000E+00	5.1984E+04		
		5	5.5095E+04	1.8322E+05	0.0000E+00	2.3832E+05		
	5	1	0.0000E+00	2.4283E+04	0.0000E+00	2.4283E+04		
		2	6.4727E+03	1.8928E+05	0.0000E+00	1.9575E+05	8.2875E+04	1.8729E+09
		3	0.0000E+00	3.9500E+02	0.0000E+00	3.9500E+02		
		4	8.2860E+03	2.0801E+04	0.0000E+00	2.9087E+04		
		5	8.9222E+04	1.5074E+05	0.0000E+00	2.3996E+05		
		6	1.0421E+03	6.7310E+03	0.0000E+00	7.7731E+03		
	TOTAL						1.1264E+06	4.4959E+10
TOTAL FOR BOTH LAKES							9.6352E+06	1.1691E+12

Table 3. Areas, volume and fish density estimates in Kenai and Skilak Lakes, Alaska, night survey, 2 and 7 October 1992.

	Skilak Lake		
Area	Surface Area ($m^3 \times 10^6$)	Volume ($m^3 \times 10^6$)	Density of Fish (%)
1	43.03 (43.5%)	2572.0 (38.3%)	66.5
2	33.46 (33.8%)	2611.0 (38.8%)	24.7
3	22.50 (22.7%)	1543.0 (22.9%)	8.8
Total	98.99 (100.0%)	6726.0 (100.0%)	100.0

	Kenai Lake		
Area	Surface Area ($m^3 \times 10^6$)	Volume ($m^3 \times 10^6$)	Density of Fish (%)
1	7.72 (13.9%)	197.5 (5.3%)	34.9
2	11.91 (21.5%)	790.7 (21.3%)	33.2
3	10.54 (19.0%)	878.4 (23.7%)	8.2
4	14.37 (25.9%)	1213.4 (32.7%)	16.4
5	10.93 (19.7%)	633.7 (17.0%)	7.3
Total	55.47 (100.0%)	3713.7 (100.0%)	100.0

Table 4. Estimated contribution of age-0 and age-1 sockeye salmon to the total fish population in Kenai and Skilak Lakes, Alaska, night survey, October 1992.

Location	Total Fish	Estimated Sockeye Salmon	Percent Age-0[a]	Total Age-0	Percent Age-1[a]	Total Age-1
Skilak Lake	8,508,900	8,485,075	98.9	8,391,739	1.1	93,336
Kenai Lake	1,126,400	1,123,246	99.2	1,114,260	0.8	8,986
Total[b]	9,635,300	9,608,300		9,506,000		102,300
Variance				1.1442E+12		5.6573E+8

[a] Age composition sample size for Skilak Lake = 893, for Kenai Lake = 1,504.
[b] Rounded to nearest 100 fish.

Table 5. Age, length, and weight of sockeye salmon collected in Skilak and Kenai Lakes, Alaska, 1992.

		Age-0				Age-1			
Location	Date	Mean[a] Length (mm)	Standard Deviation (mm)	Mean Weight (g)	Standard Deviation (g)	Mean[a] Length (mm)	Standard Deviation (mm)	Mean Weight (g)	Standard Deviation (g)
Skilak Lake									
	9/21-23/92	54 (n=883)	6	1.7 (n=883)	0.6	89 (n=10)	3	7 (n=10)	0.8
	11/2/92	57 (n=858)	6	1.8 (n=858)	0.6				
	12/3/92	59 (n=104)	6	1.8 (n=104)	0.6				
Kenai Lake									
	9/9-18/92	56 (n=1492)	7	2.0 (n=1492)	0.8	78 (n=12)	10	5.6 (n=12)	1.7

[a] Fork length.

Table 6. Mean size of age-0 sockeye salmon juveniles sampled from Skilak, Kenai, and Tustumena Lakes during late fall (September-October).

Lake	Sample year	Sample size	Length (mm)	Standard deviation	Weight (g)	Standard deviation
Skilak	1986	15	57	[a]		
	1988	109	50	5.3	0.9	0.4
	1989	136	50	3.3	1.2	0.3
	1990	928	49	4.3	1.3	0.3
	1991	863	51	4.9	1.5	0.5
	1992	883	54	6.0	1.7	0.6
Kenai	1986	227	52			
	1989	38	48	4.5	1.0	0.2
	1990	1484	52	4.6	1.5	0.4
	1991	1364	54	6.5	2.0	0.6
	1992	1492	56	7.0	2.0	0.8
Tustumena	1980	222	59	6.1	2.3	0.7
	1981	197	55	5.1	1.6	0.4
	1982	194	54	5.1	1.8	0.5
	1983	562	60	6.1	2.5	0.7
	1984	388	61	4.6	2.5	0.6
	1985	173	56	5.6	2.1	0.6
	1986	156	50	6.4	1.3	0.5
	1987	143	53	5.9	1.8	0.6
	1988	303	55	5.3	1.8	0.5
	1989	47	52	5.7	1.9	0.6
	1990	200	57	5.5	1.5	0.4
	1991	202	57	5.4	2.0	0.5
	1992	324	60	4.4	2.0	0.4

[a] Missing data indicate no available data.

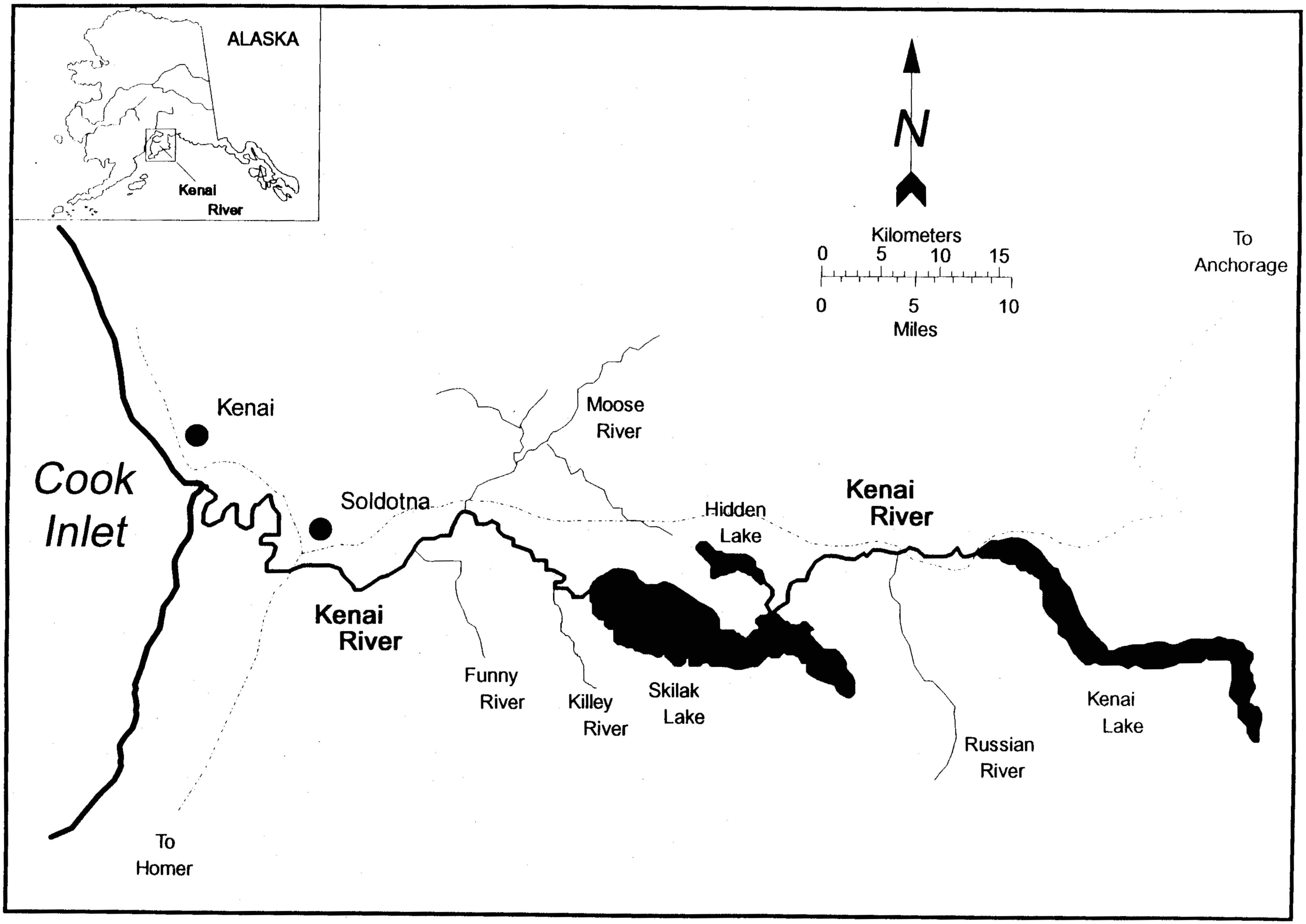


Figure 1. Map of the Kenai River drainage

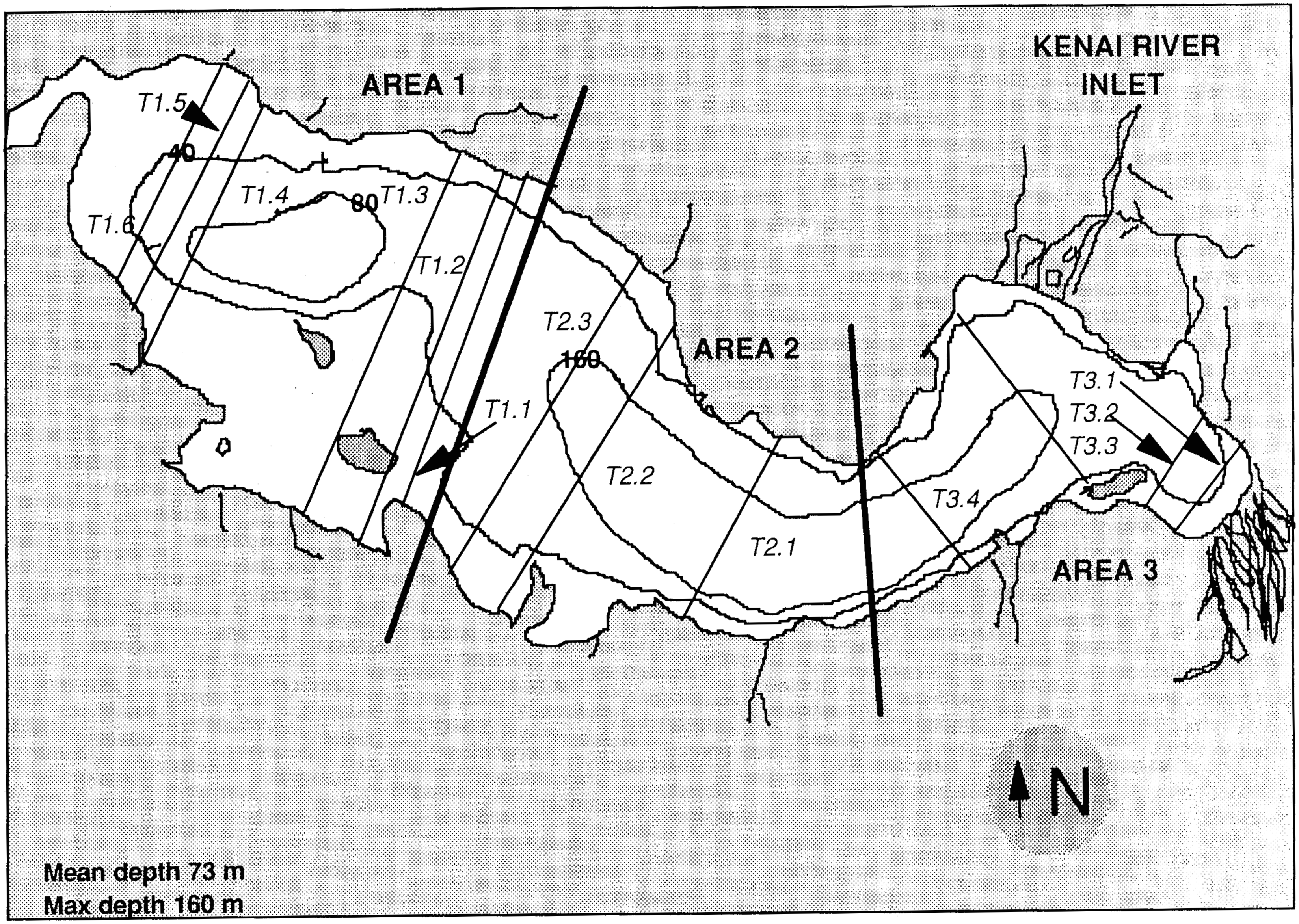


Figure 2. Location of hydroacoustic transects in Skilak Lake, Alaska, 2 October 1992.

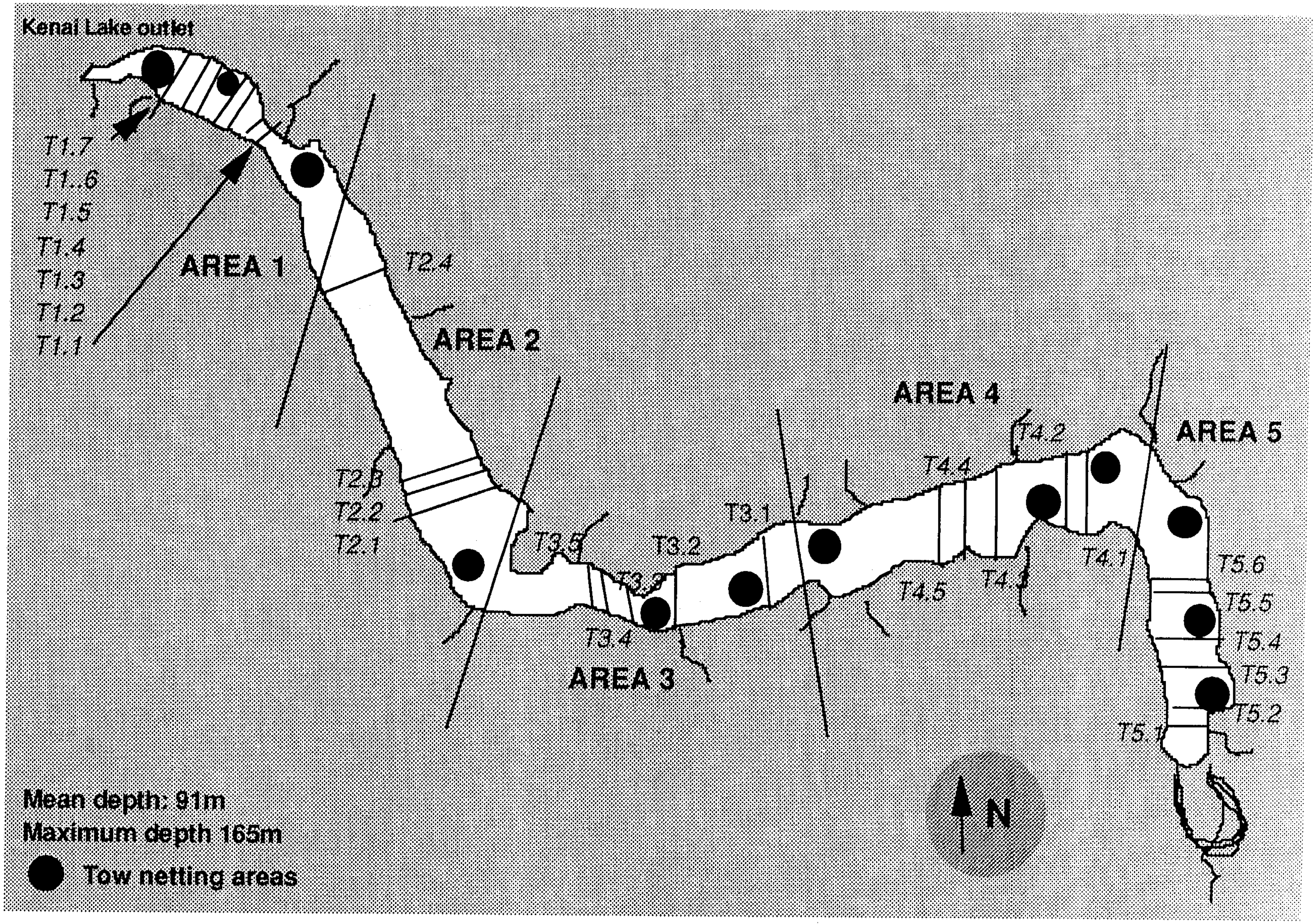


Figure 3. Location of hydroacoustic transects and tow netting areas in Kenai Lake, Alaska, in September-October, 1992.

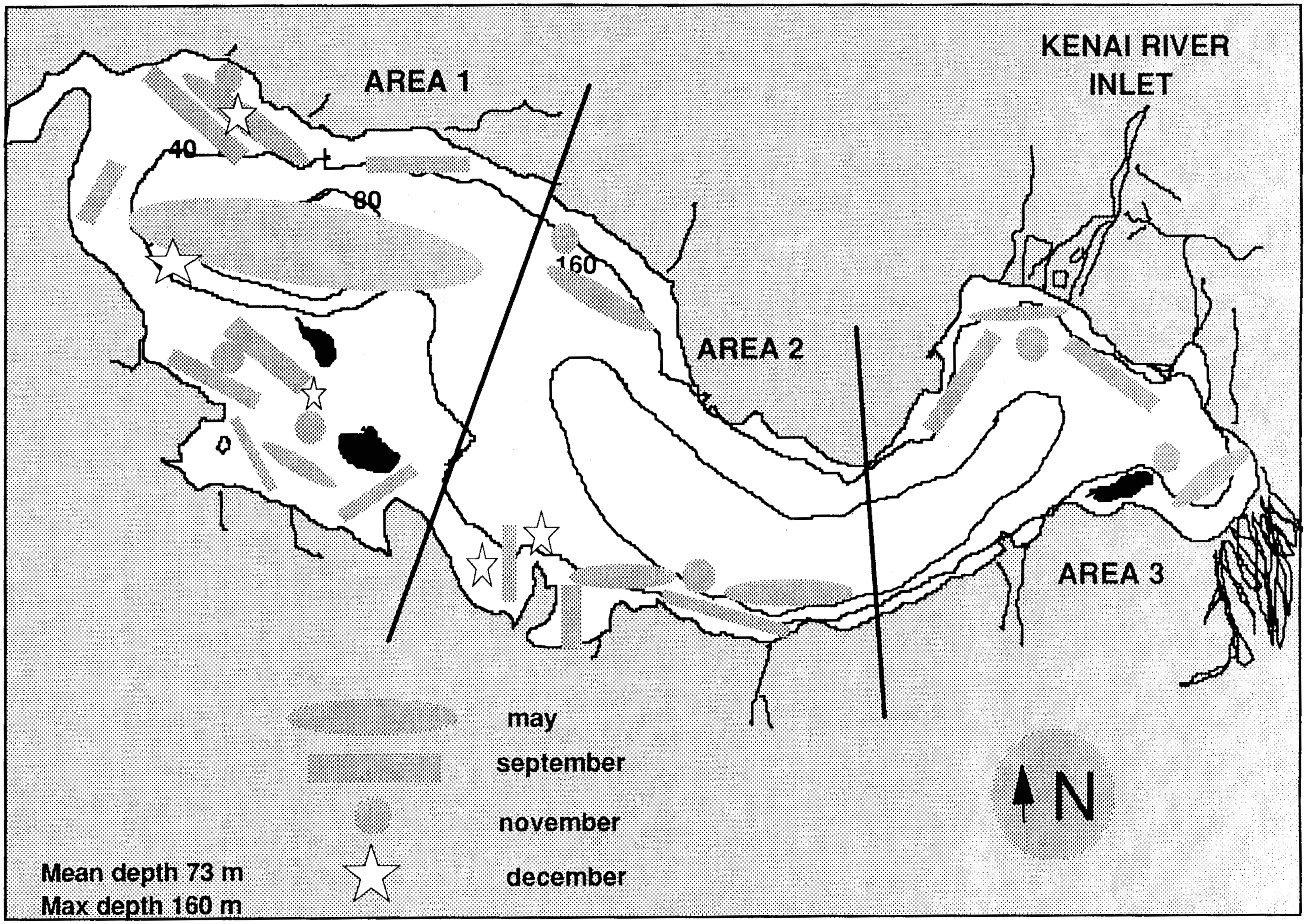


Figure 4. Tow netting areas in Skilak Lake, Alaska, 1992.

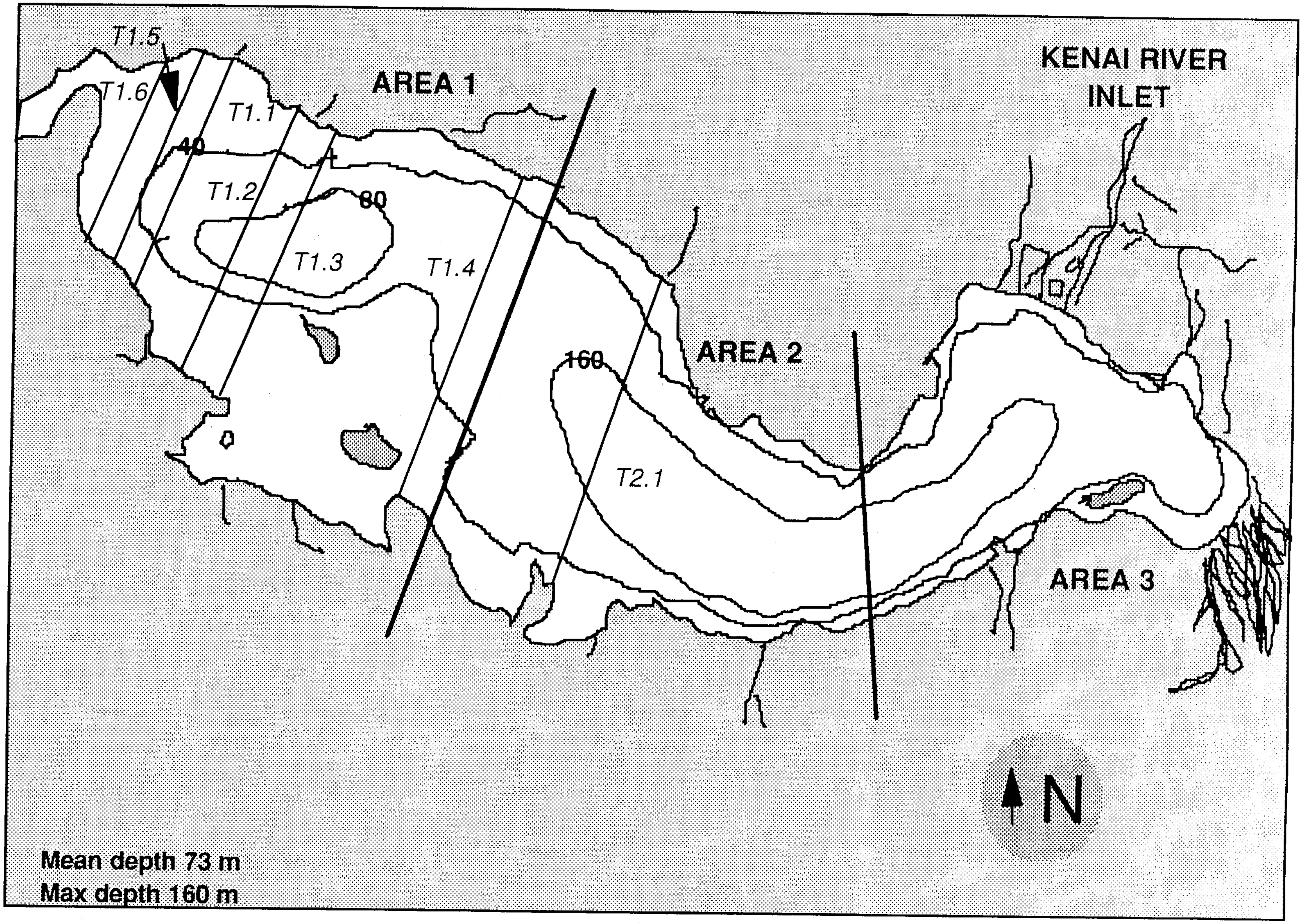


Figure 5. Location of hydroacoustic transects in Skilak Lake, Alaska, 14 May 1992.

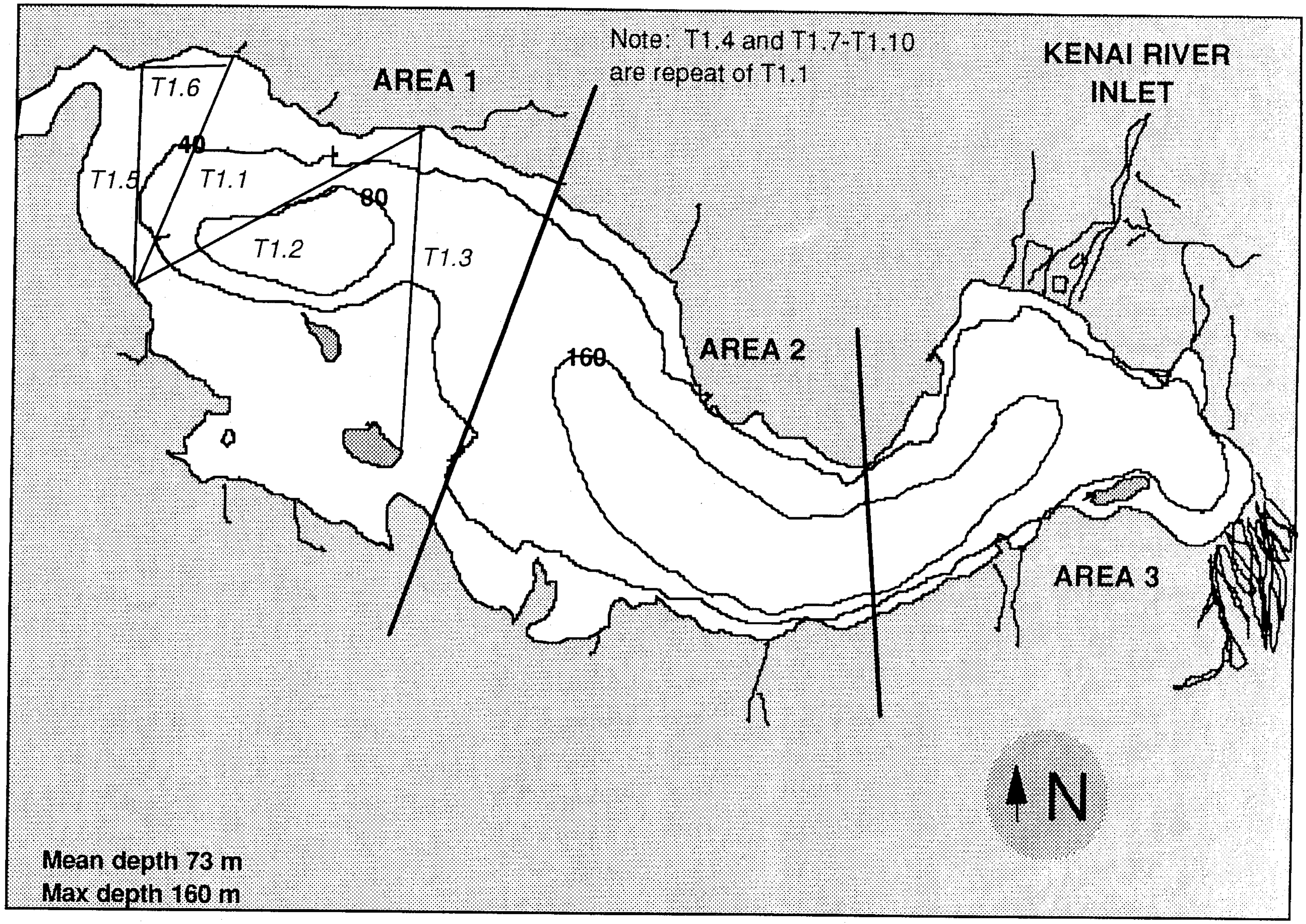


Figure 6. Location of hydroacoustic transects in Skilak Lake, Alaska, 20 May 1992.

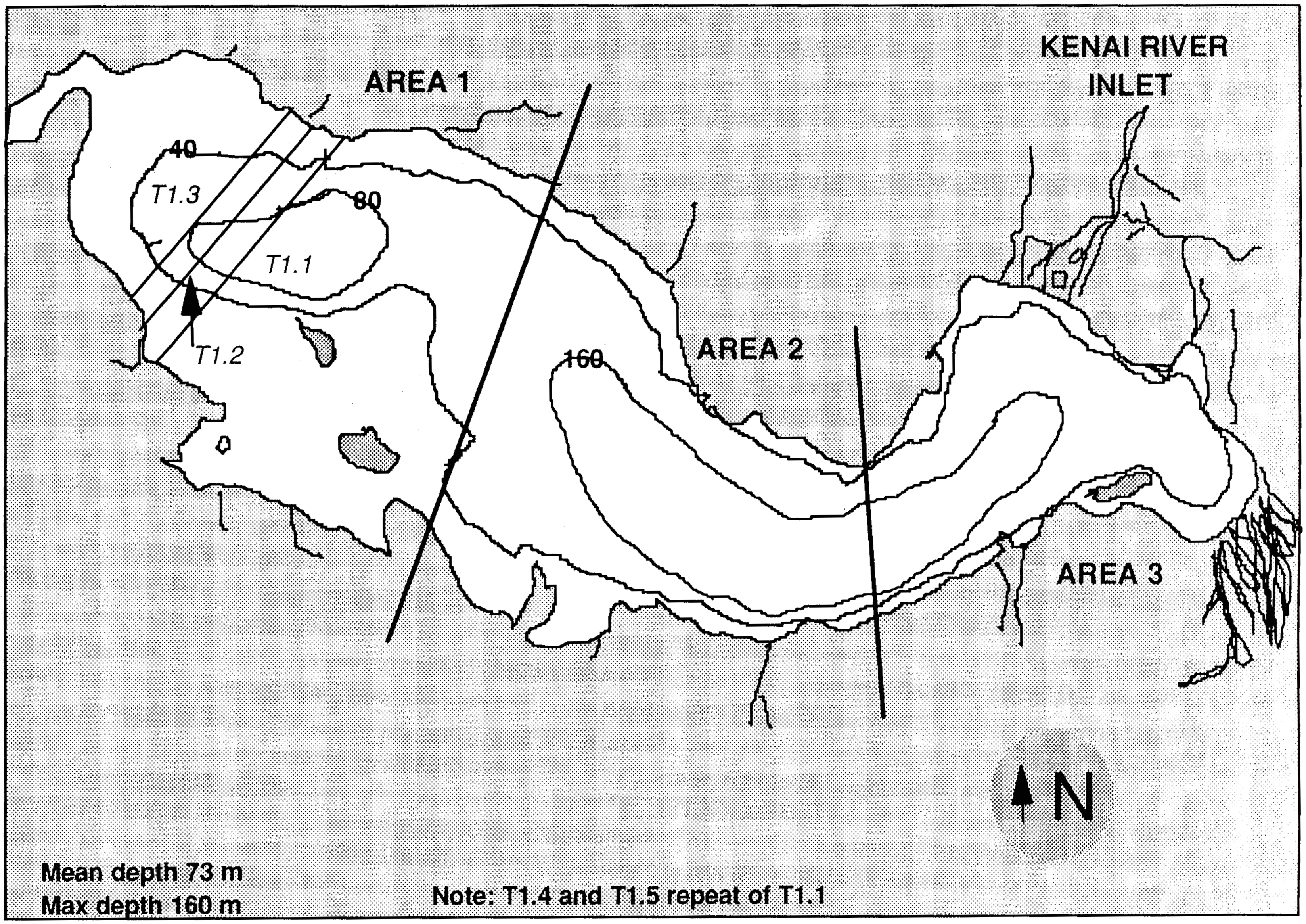
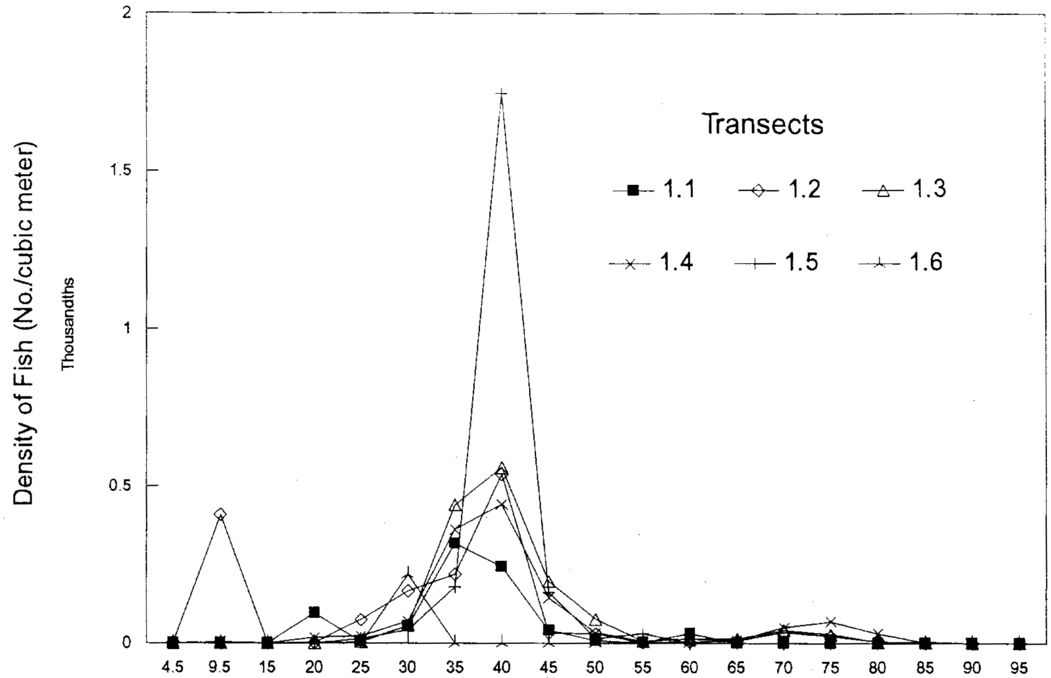


Figure 7. Location of hydroacoustic transects in Skilak Lake, Alaska, 13 October 1992.



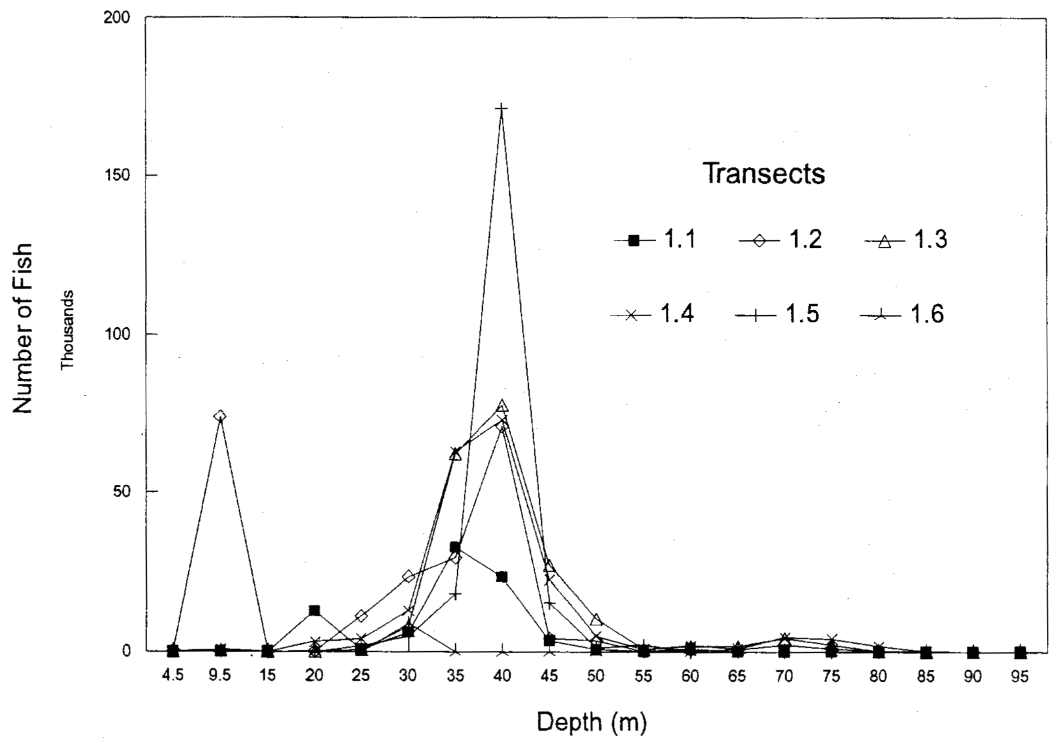


Figure 8. Density (top) and number (bottom) of fish in Skilak Lake, Alaska on 14 May 1992 (Area 1 only).

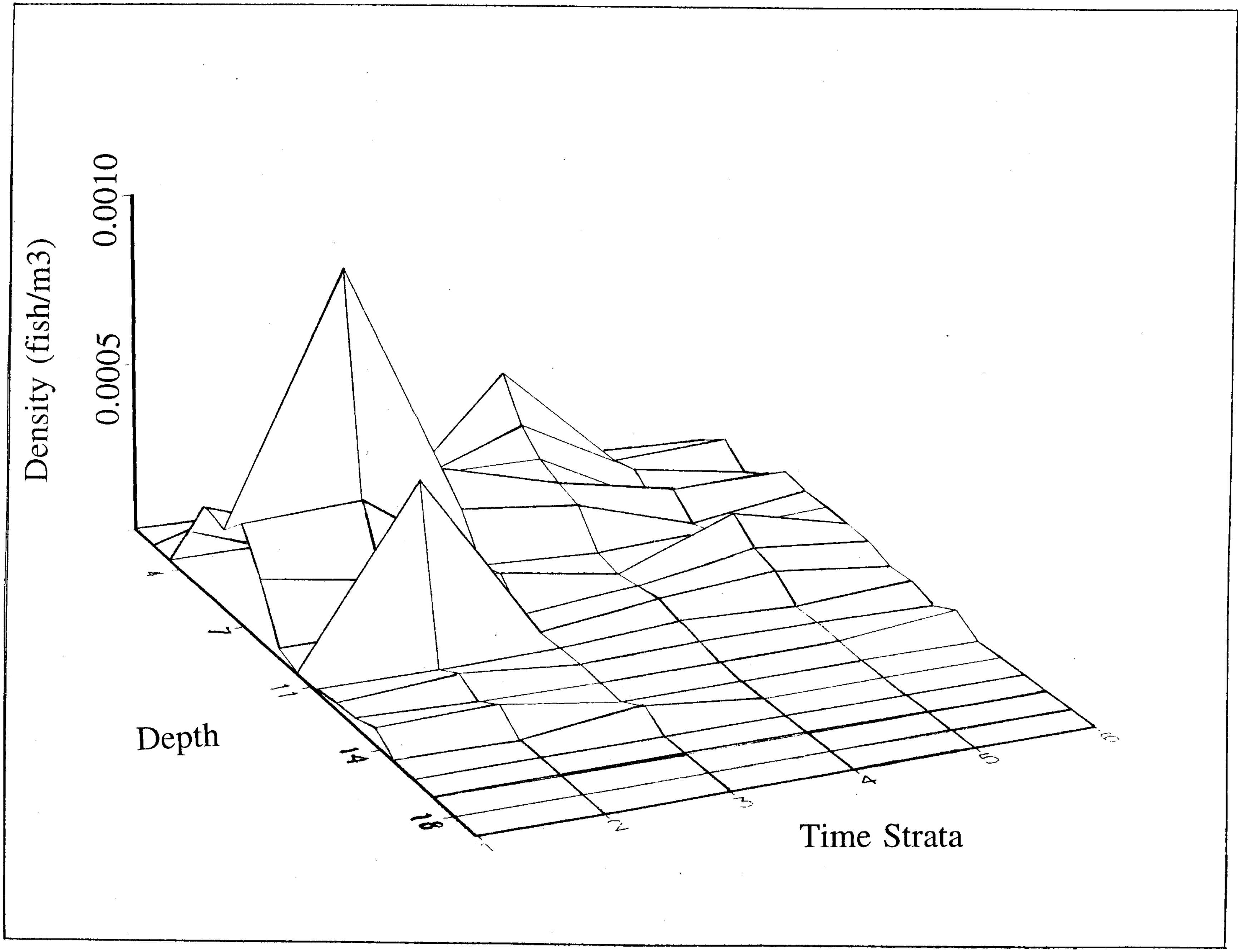


Figure 9. Fish density and depth distribution by time strata in Skilak Lake, Alaska, on 20 May 1992.

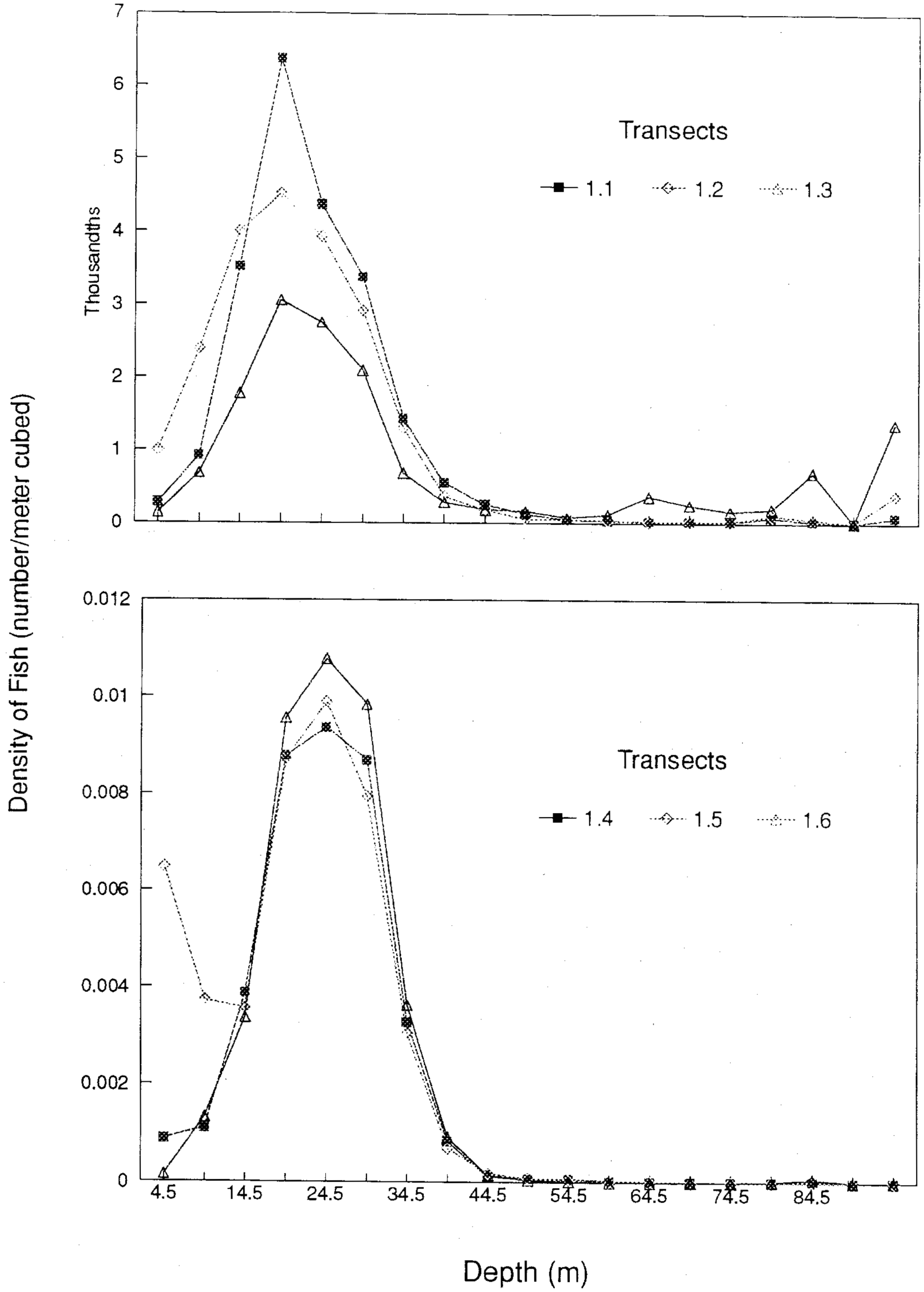


Figure 10. Density of fish in Area 1, Skilak Lake, during a night survey on 2 October 1992.

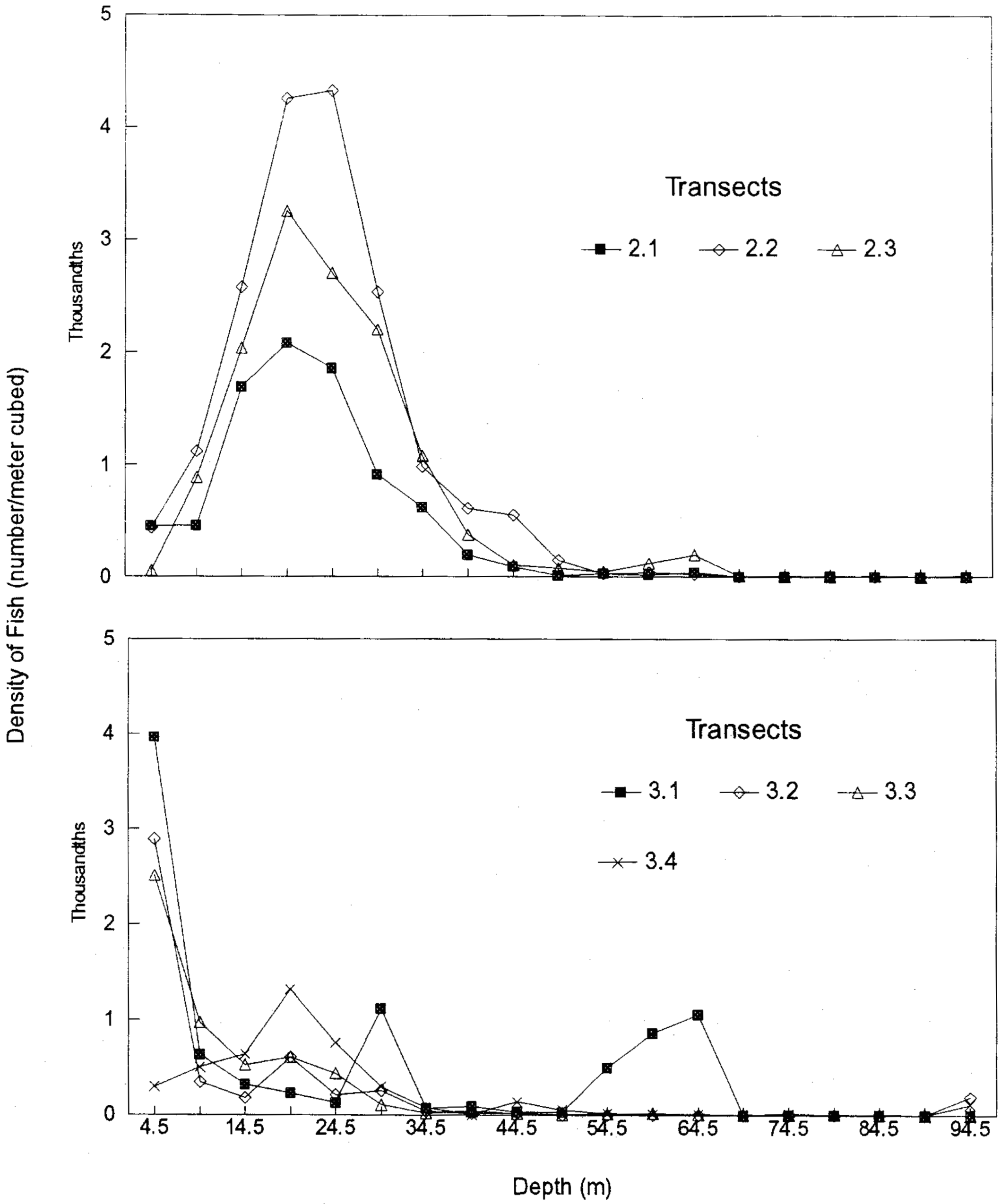


Figure 11. Density of fish in Area 2 (top) and 3 (bottom) in Skilak Lake, Alaska during a night survey on 2 October 1992.

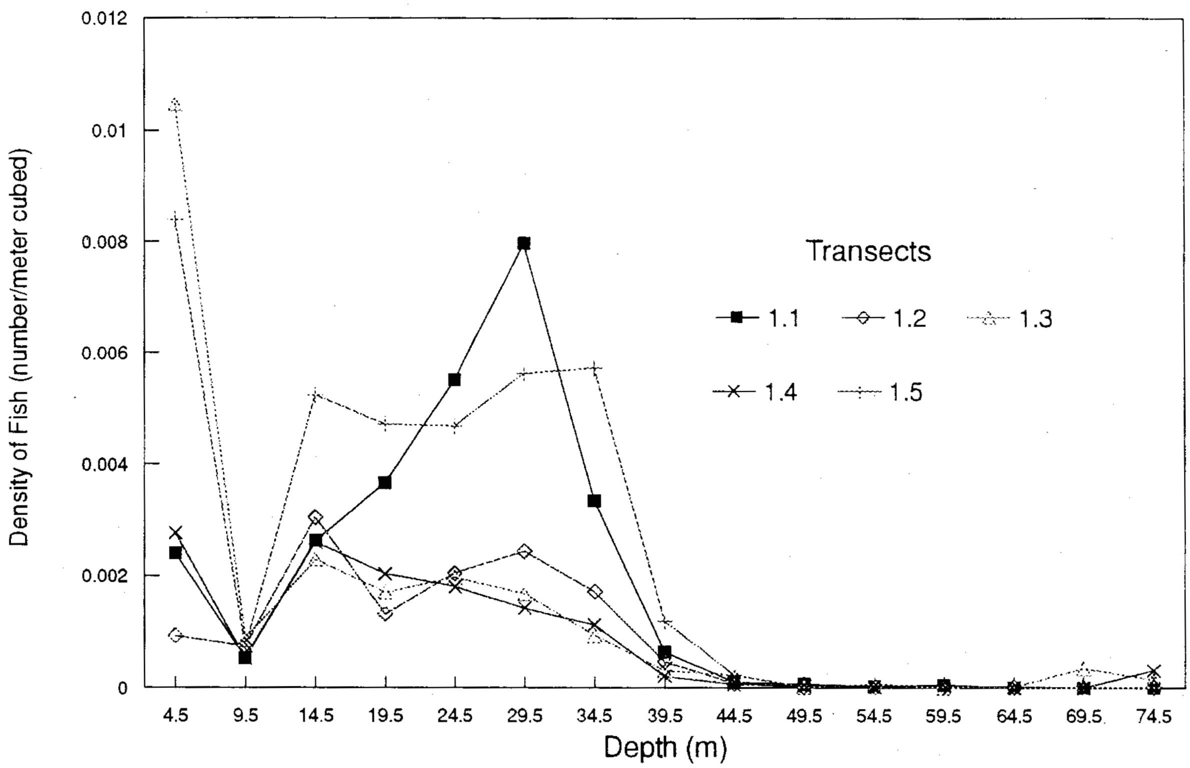


Figure 12. Density of fish in Skilak Lake, Area 1, during a day survey on 13 October 1992.

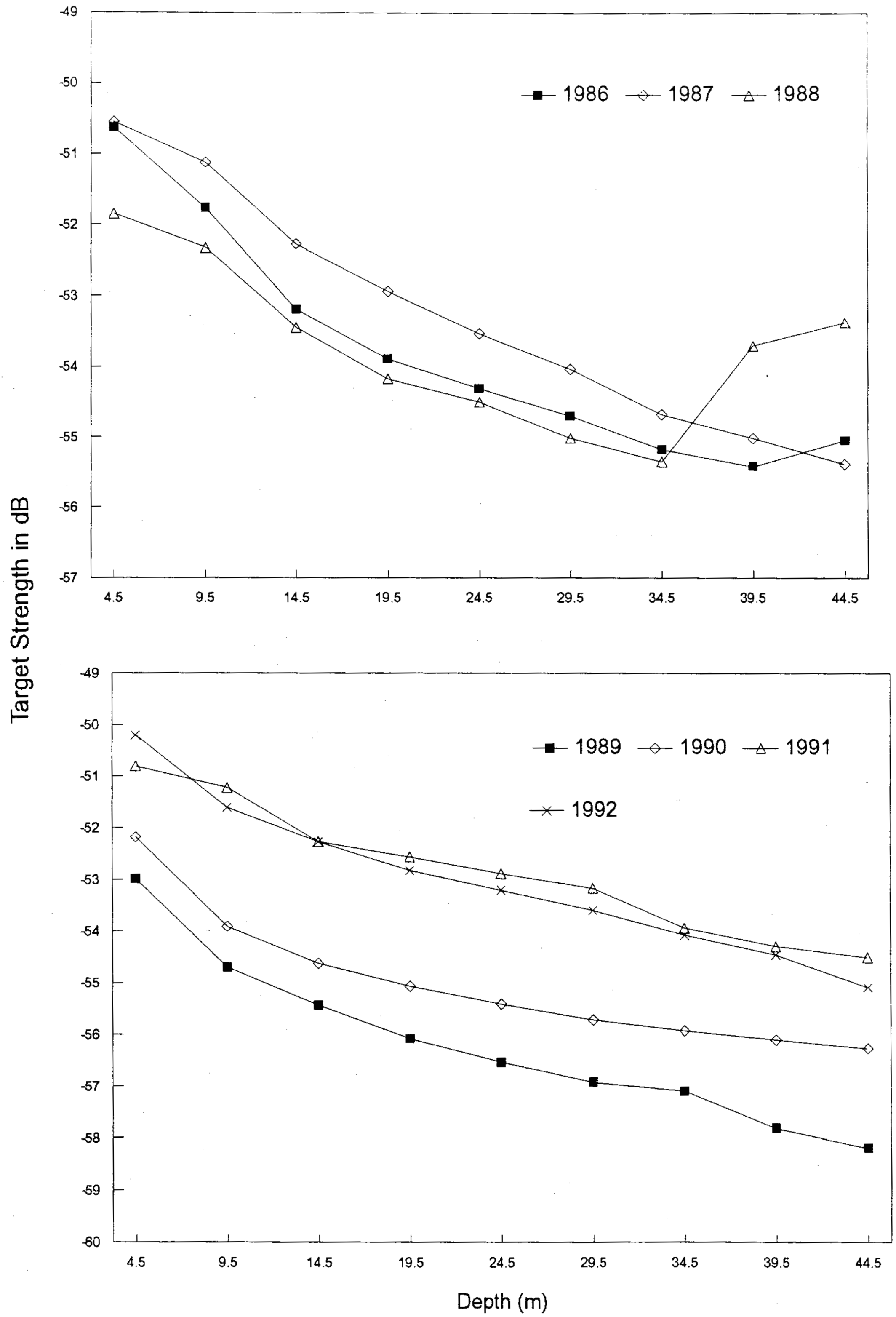


Figure 13. Fish target strengths measured in Skilak Lake, Alaska.

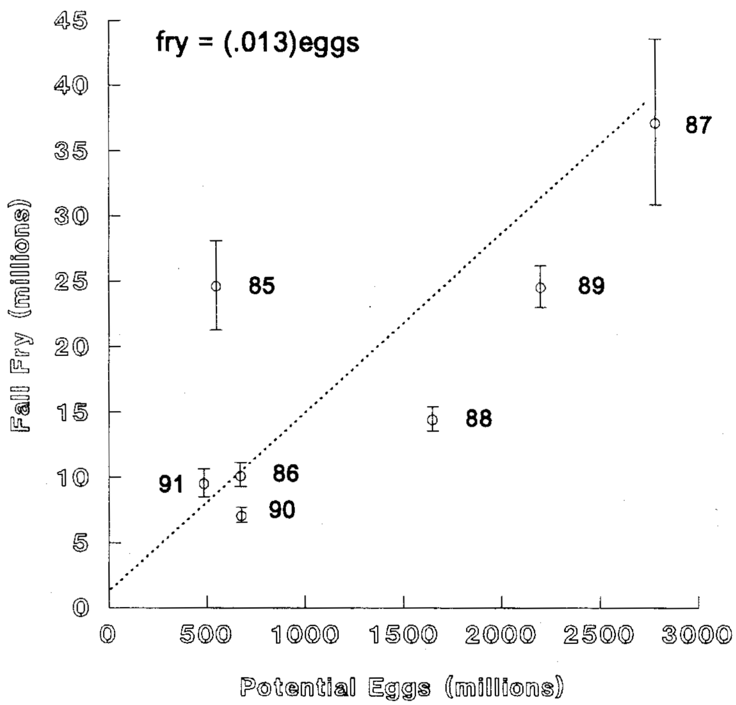


Figure 14. Relationship between number of age-0 fall fry in Kenai and Skilak lakes and mainstem potential egg deposition. Values listed indicate brood year of the eggs and fry. Vertical bars are standard errors of estimated fry abundances (source: Schmidt et al. 1993).

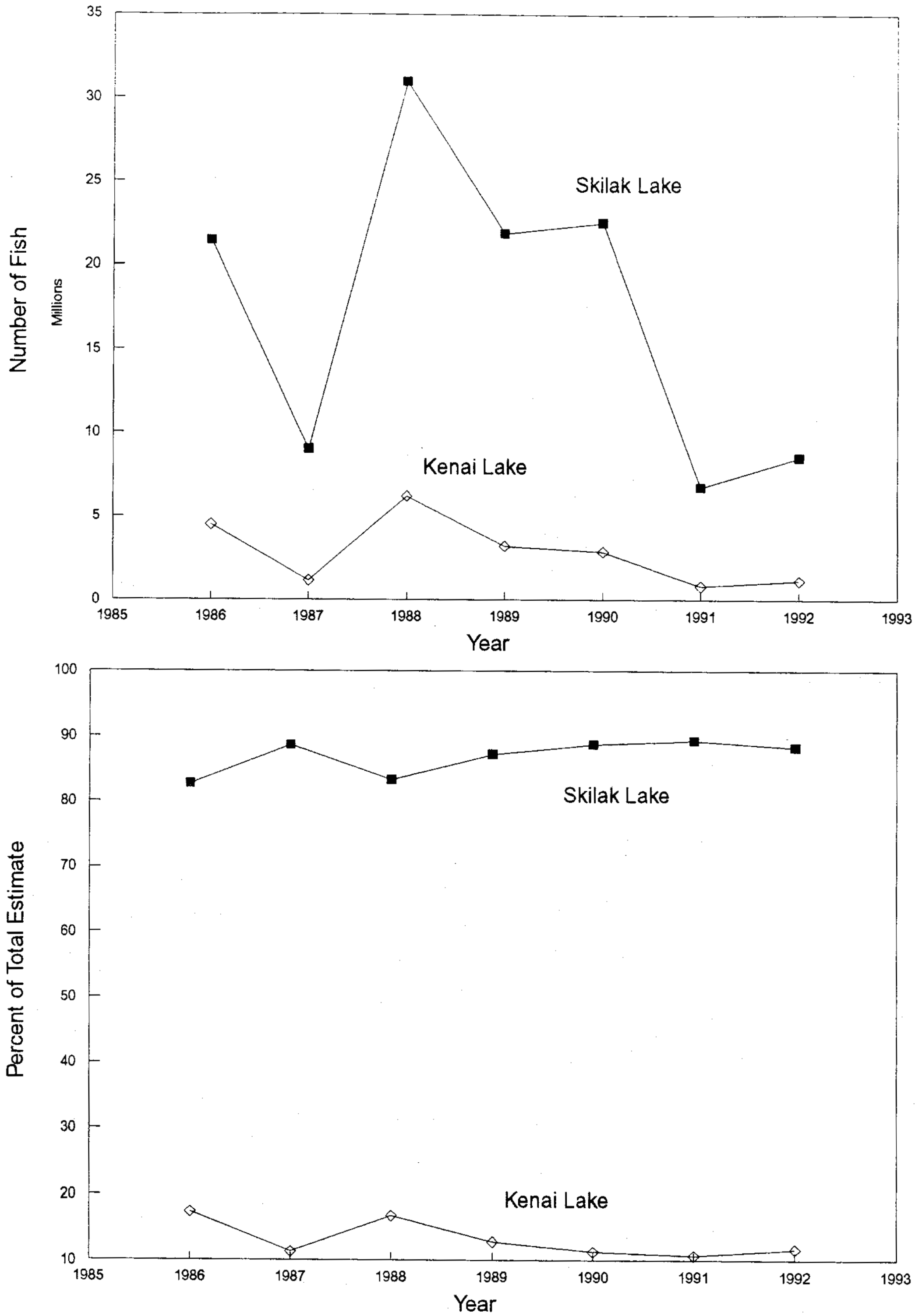


Figure 15. Relative distribution of juvenile sockeye salmon in the Kenai River system, Alaska 1986 - 1992.

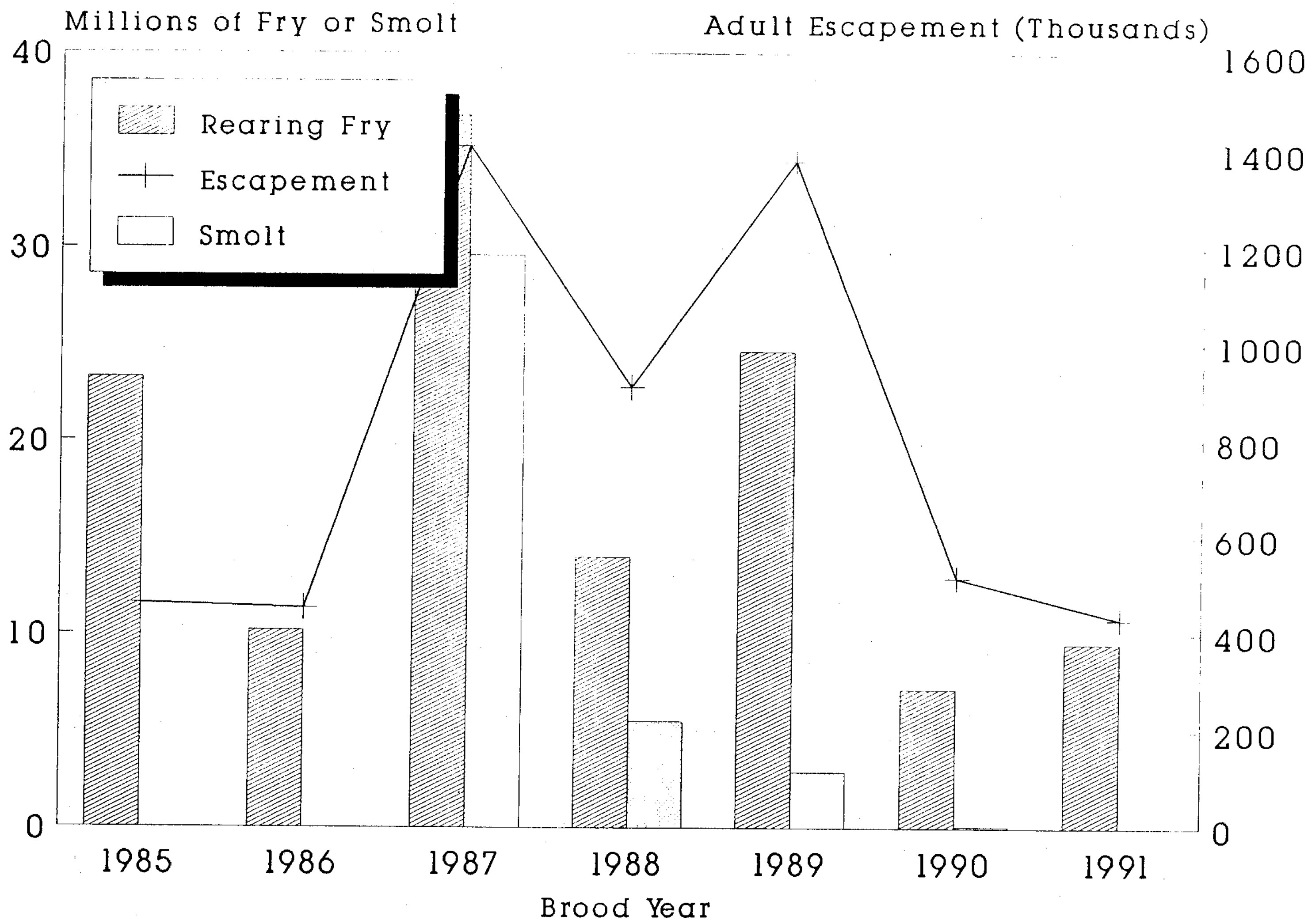


Figure 16. Estimated number of age-0 sockeye salmon smolt rearing and leaving Kenai and Skilak Lakes, Alaska, by brood year.

APPENDIX

Appendix A.1. Calibration and processing parameters used in collection and analysis of Kenai and Skilak Lakes, Alaska, 1992 hydroacoustic data.

MAY, 1992				
Sounder 420 kHz	Receiving sensitivity (dB/uP@1m)	Channel 1	40 log R =	-165.44 dB
			20 log R =	-144.07 dB
		Channel 2	40 log R =	-166.61 dB
			20 log R =	-144.72 dB
	Source level (dB/uP@1m)			217.67dB
	TVG Crossover			11.72 m
	Receiver gain			0 dB
Transducer	Beam width	Narrow		6 degree
		Wide		15 degree
	Wide beam dropoff	"A" coefficient		1.174 dB
		"B" coefficient		0.622 dB
	Beam pattern factor	Average squared value	Narrow	.001052
Dual-beam processor	Correction multiplier	Narrow beam		1.000
		Wide beam		1.144
	Threshold	Narrow beam		200 mV
		Wide beam		200 mV
		Bottom		9999 mV
	Maximum half angle			4^{o}
	Pulse width criteria	-18 dB	Maximum	.9478 mS
		-6 dB	Minimum	.2800 mS
		-6 dB	Maximum	.5200 mS
	Bottom window			2.0 meters
	Start depth			2.0 meters
		Depth		
Echo integrator	B constant value	2.0 - 7.0 m		6.7878
		7.0 - 12.0 m		1.5230
		12.0 - 17.0 m		0.6538
		17.0 - 22.0 m		0.3615
		22.0 - 27.0 m		0.2290
		27.0 - 32.0 m		0.1579
		32.0 - 37.0 m		0.1155
		37.0 - 42.0 m		0.0881
		42.0 - 47.0 m		0.0694
		47.0 - 52.0 m		0.0561
		52.0 - 57.0 m		0.0463
		57.0 - 62.0 m		0.0388
		62.0 - 67.0 m		0.0330
		67.0 - 72.0 m		0.0285
		72.0 - 77.0 m		0.0248
		77.0 - 82.0 m		0.0217
		82.0 - 87.0 m		0.0193
		87.0 - 92.0 m		0.0172
		92.0 - 97.0 m		0.0154

continued

OCTOBER, 1992

Sounder 420 kHz	Receiving sensitivity (dB/uPa@1m)	Channel 1	40 log R =	-165.77 dB
			20 log R =	-144.31 dB
		Channel 2	40 log R =	-165.67 dB
			20 log R =	-143.66 dB
	Source level (dB/uPa@1m)			217.66dB
	TVG Crossover			11.75 m
	Receiver gain			0 dB
Transducer	Beam width	Narrow		6 degree
		Wide		15 degree
	Wide beam dropoff	"A" coefficient		1.289 dB
		"B" coefficient		0.610 dB
	Beam pattern factor	Average squared value	Narrow	.001052
Dual-beam processor	Correction multiplier	Narrow beam		1.000
		Wide beam		0.988
	Threshold	Narrow beam		200 mV
		Wide beam		200 mV
		Bottom		7000 mV
	Maximum half angle			4^{o}
	Pulse width criteria	-18 dB	Maximum	.9478 mS
		-6 dB	Minimum	.2800 mS
		-6 dB	Maximum	.5200 mS
	Bottom window			2.0 meters
	Start depth			2.0 meters
		Depth		
Echo integrator	B constant value	2.0 - 7.0 m		6.9169
		7.0 - 12.0 m		1.5519
		12.0 - 17.0 m		0.6662
		17.0 - 22.0 m		0.3684
		22.0 - 27.0 m		0.2333
		27.0 - 32.0 m		0.1609
		32.0 - 37.0 m		0.1176
		37.0 - 42.0 m		0.0898
		42.0 - 47.0 m		0.0707
		47.0 - 52.0 m		0.0572
		52.0 - 57.0 m		0.0472
		57.0 - 62.0 m		0.0396
		62.0 - 67.0 m		0.0337
		67.0 - 72.0 m		0.0290
		72.0 - 77.0 m		0.0252
		77.0 - 82.0 m		0.0222
		82.0 - 87.0 m		0.0196
		87.0 - 92.0 m		0.0175
		92.0 - 97.0 m		0.0157

Appendix A.2. Average backscattering cross section (sigma) and target strength data by depth strata for all day transects combined, Skilak Lake, Alaska, 14 and 20 May 1992.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	20	.5936E-04	.1955E-03	-49.79	7.02
7.0 - 12.0	13	.4045E-04	.9109E-04	-51.02	8.37
12.0 - 17.0	80	.2690E-04	.4613E-04	-49.65	6.21
17.0 - 22.0	116	.2931E-04	.6287E-04	-50.06	5.86
22.0 - 27.0	294	.2114E-04	.5907E-04	-51.89	5.73
27.0 - 32.0	421	.9453E-05	.1814E-04	-53.59	5.21
32.0 - 37.0	743	.1104E-04	.3134E-04	-53.82	5.46
37.0 - 42.0	1356	.6196E-05	.1080E-04	-54.46	4.44
42.0 - 47.0	885	.4367E-05	.4722E-05	-55.32	3.87
47.0 - 52.0	412	.5841E-05	.1266E-04	-54.75	4.15
52.0 - 57.0	205	.5495E-05	.5216E-05	-54.62	4.50
57.0 - 62.0	183	.3282E-05	.3041E-05	-56.37	3.74
62.0 - 67.0	240	.3471E-05	.3478E-05	-56.30	3.84
67.0 - 72.0	365	.2766E-05	.2979E-05	-57.09	3.48
72.0 - 77.0	229	.2589E-05	.1906E-05	-56.96	3.17
77.0 - 82.0	57	.2161E-05	.1451E-05	-57.64	3.01
82.0 - 87.0	4	.1427E-05	.1018E-05	-59.46	3.57
87.0 - 92.0	0	.0000E-00	.0000E-00	-00.00	0.00
92.0 - 97.0	0	.0000E-00	.0000E-00	-00.00	0.00
Total	5623	.7936E-05	.2616E-04	-54.60	4.82

[a] Target strength determined from dual-beam data collected *in situ*.

Appendix A.3. Average backscattering cross section (sigma) and target strength data by depth strata for all night transects combined, Kenai Lake, Alaska, 7 October 1992.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	16	.1677E-04	.2527E-04	-51.44	5.66
7.0 - 12.0	225	.1497E-04	.3550E-04	-52.53	5.75
12.0 - 17.0	627	.1242E-04	.3380E-04	-52.75	5.52
17.0 - 22.0	1223	.7990E-05	.8087E-05	-53.45	5.13
22.0 - 27.0	1689	.7411E-05	.1208E-04	-53.58	4.84
27.0 - 32.0	1881	.6397E-05	.5861E-05	-53.79	4.41
32.0 - 37.0	991	.5243E-05	.4188E-05	-54.34	4.05
37.0 - 42.0	552	.4846E-05	.4046E-05	-54.79	4.11
42.0 - 47.0	176	.4376E-05	.3891E-05	-55.00	3.72
47.0 - 52.0	56	.3963E-05	.3628E-05	-55.77	4.15
52.0 - 57.0	30	.3354E-05	.2464E-05	-56.04	3.62
57.0 - 62.0	1	.2455E-05	.0000E-00	-56.10	0.00
62.0 - 67.0	13	.2968E-05	.2797E-05	-56.83	3.83
67.0 - 72.0	7	.2999E-05	.1243E-05	-55.68	2.33
72.0 - 77.0	2	.2819E-05	.3525E-05	-58.80	8.57
77.0 - 82.0	1	.3851E-06	.0000E-00	-64.14	0.00
82.0 - 87.0	0	.0000E-00	.0000E-00	-00.00	0.00
87.0 - 92.0	1	.3222E-05	.0000E-00	-54.92	0.00
92.0 - 97.0	0	.0000E-00	.0000E-00	00.00	0.00
Total	7491	.7313E-05	.1402E-04	-53.77	4.74

[a] Target strength determined from dual-beam data collected *in situ*.

Appendix A.4. Average backscattering cross section (sigma) and target strength data by depth strata for all night transects combined, Skilak Lake, Alaska, 2 October 1992.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	152	.1793E-04	.2098E-04	-50.21	5.35
7.0 - 12.0	529	.1320E-04	.1436E-04	-51.61	5.54
12.0 - 17.0	2334	.1052E-04	.1545E-04	-52.27	5.06
17.0 - 22.0	5771	.8505E-05	.8097E-05	-52.83	4.80
22.0 - 27.0	7630	.7705E-05	.8162E-05	-53.21	4.63
27.0 - 32.0	8347	.6703E-05	.6592E-05	-53.60	4.40
32.0 - 37.0	5340	.5934E-05	.5736E-05	-54.08	4.28
37.0 - 42.0	2276	.5212E-05	.5039E-05	-54.46	3.97
42.0 - 47.0	779	.4673E-05	.4497E-05	-55.09	4.16
47.0 - 52.0	435	.5600E-05	.5490E-05	-54.23	3.97
52.0 - 57.0	308	.8310E-05	.1097E-05	-53.48	4.89
57.0 - 62.0	123	.6311E-05	.5587E-05	-53.93	4.47
62.0 - 67.0	63	.4806E-05	.4602E-05	-55.19	4.48
67.0 - 72.0	75	.7668E-05	.5932E-05	-52.46	3.65
72.0 - 77.0	17	.5717E-05	.5301E-05	-54.67	5.02
77.0 - 82.0	7	.2804E-05	.2096E-05	-56.20	2.36
82.0 - 87.0	5	.3014E-05	.3062E-05	-56.93	4.39
87.0 - 92.0	0	.0000E-05	.0000E-00	-00.00	0.00
92.0 - 97.0	1	.2458E-05	.0000E-00	-56.09	0.00
Total	34192	.7372E-05	.8358E-05	-53.42	4.59

[a] Target strength determined from dual-beam data collected *in situ*.

Appendix A.5. Average backscattering cross section (sigma) and target strength data by depth strata for all day transects combined, Skilak Lake, Alaska, 13 October 1992.

Depth Stratum (m)	Number of Targets	Sigma Mean	Sigma Standard Deviation	Target[a] Strength Mean (dB)	Target Strength Standard Deviation (dB)
2.0 - 7.0	9	.7757E-05	.7420E-05	-53.12	4.94
7.0 - 12.0	89	.3783E-04	.8313E-04	-48.53	6.17
12.0 - 17.0	593	.1180E-04	.1711E-04	-52.07	5.21
17.0 - 22.0	1181	.9466E-05	.1230E-05	-52.67	4.80
22.0 - 27.0	2347	.8259E-05	.8331E-05	-52.80	4.50
27.0 - 32.0	2922	.7456E-05	.7488E-05	-53.08	4.24
32.0 - 37.0	2280	.6161E-05	.5629E-05	-53.73	4.03
37.0 - 42.0	811	.5275E-05	.4528E-05	-54.31	3.96
42.0 - 47.0	236	.6295E-05	.7512E-05	-53.64	3.87
47.0 - 52.0	71	.1142E-04	.1864E-04	-52.62	5.18
52.0 - 57.0	54	.9793E-05	.8117E-05	-51.52	3.78
57.0 - 62.0	65	.1192E-04	.1047E-04	-51.06	4.44
62.0 - 67.0	17	.1187E-04	.1126E-04	-51.41	4.98
67.0 - 72.0	35	.7247E-05	.5918E-05	-52.45	3.01
72.0 - 77.0	23	.5858E-05	.5061E-05	-54.14	4.44
77.0 - 82.0	0	.0000E-00	.0000E-00	-00.00	0.00
82.0 - 87.0	0	.0000E-00	.0000E-00	-00.00	0.00
87.0 - 92.0	0	.0000E-00	.0000E-00	-00.00	0.00
92.0 - 97.0	0	.0000E-00	.0000E-00	-00.00	0.00
Total	10733	.7947E-05	.1196E-04	-53.10	4.43

[a] Target strength determined from dual-beam data collected *in situ*.

Appendix A.6. Estimated number of fish not available to the hydroacoustic equipment because of surface orientation in Skilak and Kenai Lakes, Alaska during night survey of 2 and 7 October 1992.

Lake	Area	Transect	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
Skilak	1	1	2.7350E-04	1.2909E+08	3.5306E+04
		2	9.9680E-04	1.2909E+08	1.2868E+05
		3	1.3690E-04	1.2909E+08	1.7672E+04
		4	8.8940E-04	1.2909E+08	1.1481E+05
		5	6.4870E-03	1.2909E+08	8.3741E+05
		6	1.5610E-04	1.2909E+08	2.0151E+04
	2	1	4.5440E-04	1.0038E+08	4.5613E+04
		2	4.3900E-04	1.0038E+08	4.4067E+04
		3	5.4390E-05	1.0038E+08	5.4597E+03
	3	1	3.9610E-03	6.7500E+07	2.6737E+05
		2	2.8900E-03	6.7500E+07	1.9508E+05
		3	2.5110E-03	6.7500E+07	1.6949E+05
		4	2.9460E-04	6.7500E+07	1.9886E+04
Kenai	1	1	1.1150E-02	2.3160E+07	2.5823E+05
		2	3.7190E-04	2.3160E+07	8.6132E+03
		3	4.5680E-05	2.3160E+07	1.0579E+03
		4	1.0120E-04	2.3160E+07	2.3438E+03
		5	0.0000E+00	2.3160E+07	0.0000E+00
		6	8.4670E-06	2.3160E+07	1.9610E+02
		7	7.2830E-04	2.3160E+07	1.6867E+04
	2	1	0.0000E+00	3.5730E+07	0.0000E+00
		2	0.0000E+00	3.5730E+07	0.0000E+00
		3	3.1560E-04	3.5730E+07	1.1276E+04
		4	3.6080E-04	3.5730E+07	1.2891E+04
	3	1	0.0000E+00	3.1620E+07	0.0000E+00
		2	1.7350E-04	3.1620E+07	5.4861E+03
		3	5.1240E-05	3.1620E+07	1.6202E+03
		4	0.0000E+00	3.1620E+07	0.0000E+00
		5	1.0010E-04	3.1620E+07	3.1652E+03
	4	1	2.1360E-04	4.3110E+07	9.2083E+03
		2	1.4580E-03	4.3110E+07	6.2854E+04
		3	3.0860E-04	4.3110E+07	1.3304E+04
		4	1.0670E-04	4.3110E+07	4.5998E+03
		5	1.2780E-03	4.3110E+07	5.5095E+04
	5	1	0.0000E+00	3.2790E+07	0.0000E+00
		2	1.9740E-04	3.2790E+07	6.4727E+03
		3	0.0000E+00	3.2790E+07	0.0000E+00
		4	2.5270E-04	3.2790E+07	8.2860E+03
		5	2.7210E-03	3.2790E+07	8.9222E+04
		6	3.1780E-05	3.2790E+07	1.0421E+03

Appendix A.7. Estimated number of fish not available to the hydroacoustic equipment because of bottom orientation in Skilak Lake, Alaska, 2 October 1992.

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	1	2-7	2.7400E-04	2.5312E+06	6.9354E+02
		7-12	9.2000E-04	7.5935E+06	6.9860E+03
		12-17	3.5170E-03	7.5935E+06	2.6706E+04
		17-22	6.3690E-03	5.0624E+06	3.2242E+04
		22-27	4.3650E-03	1.0125E+07	4.4194E+04
		27-32	3.3700E-03	1.2656E+07	4.2650E+04
		32-37	1.4270E-03	2.0249E+07	2.8896E+04
		37-42	5.4400E-04	1.7718E+07	9.6387E+03
		42-47	2.4900E-04	1.7718E+07	4.4118E+03
		47-52	1.1700E-04	7.5935E+06	8.8844E+02
		52-57	4.2000E-05	7.5935E+06	3.1893E+02
		57-62	2.5000E-05	7.5935E+06	1.8984E+02
		62-67	1.4000E-05	5.0624E+06	7.0873E+01
		67-72	1.4000E-05	7.5935E+06	1.0631E+02
		72-77	1.3000E-05	1.0125E+07	1.3162E+02
		77-82	6.9000E-05	1.7718E+07	1.2226E+03
		82-87	1.2000E-05	1.5187E+07	1.8224E+02
		87-92	0.0000E+00	7.5935E+06	0.0000E+00
		92-97	7.8000E-05	7.5935E+06	5.9230E+02
		TOTAL			2.0012E+05
1	2	2-7	9.9700E-04	1.0432E+07	1.0400E+04
		7-12	2.3890E-03	1.5647E+07	3.7381E+04
		12-17	4.0100E-03	2.0863E+07	8.3661E+04
		17-22	4.5080E-03	1.0432E+07	4.7025E+04
		22-27	3.9280E-03	5.2158E+06	2.0487E+04
		27-32	2.9130E-03	1.0432E+07	3.0387E+04
		32-37	1.2990E-03	5.2158E+06	6.7753E+03
		37-42	3.6400E-04	7.8236E+06	2.8478E+03
		42-47	1.7000E-04	5.2158E+06	8.8668E+02
		47-52	5.2000E-05	7.8236E+06	4.0683E+02
		52-57	3.8000E-05	7.8236E+06	2.9730E+02
		57-62	3.2000E-05	5.2158E+06	1.6690E+02
		62-67	7.0000E-06	7.8236E+06	5.4765E+01
		67-72	1.3000E-05	5.2158E+06	6.7805E+01
		72-77	1.8000E-05	7.8236E+06	1.4083E+02
		77-82	1.0000E-04	1.0432E+07	1.0432E+03
		82-87	4.9000E-05	7.8236E+06	3.8336E+02
		87-92	0.0000E+00	7.8236E+06	0.0000E+00
		92-97	3.7600E-04	7.8236E+06	2.9417E+03
		TOTAL			2.4535E+05

continued

Appendix A.7. (p. 2 of 7)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	3	2-7	1.37E-04	2.2647E+06	3.1027E+02
		7-12	6.81E-04	1.3588E+07	9.2537E+03
		12-17	1.77E-03	1.8118E+07	3.2069E+04
		17-22	3.05E-03	1.1324E+07	3.4549E+04
		22-27	2.75E-03	4.5295E+06	1.2456E+04
		27-32	2.09E-03	4.5295E+06	9.4621E+03
		32-37	6.75E-04	4.5295E+06	3.0574E+03
		37-42	2.76E-04	6.7942E+06	1.8752E+03
		42-47	1.76E-04	6.7942E+06	1.1958E+03
		47-52	1.57E-04	1.1324E+07	1.7778E+03
		52-57	7.00E-05	2.0383E+07	1.4268E+03
		57-62	1.10E-04	1.1324E+07	1.2456E+03
		62-67	3.57E-04	4.5295E+06	1.6170E+03
		67-72	2.42E-04	6.7942E+06	1.6442E+03
		72-77	1.55E-04	6.7942E+06	1.0531E+03
		77-82	1.87E-04	1.1324E+07	2.1175E+03
		82-87	6.90E-04	9.0589E+06	6.2507E+03
		87-92	0.00E+00	6.7942E+06	0.0000E+00
		92-97	1.36E-03	9.0589E+06	1.2338E+04
		TOTAL			1.3370E+05
1	4	2-7	8.89E-04	1.4343E+07	1.2751E+04
		7-12	1.11E-03	2.1515E+07	2.3839E+04
		12-17	3.88E-03	2.5101E+07	9.7416E+04
		17-22	8.77E-03	1.0758E+07	9.4386E+04
		22-27	9.36E-03	7.1717E+06	6.7120E+04
		27-32	8.68E-03	1.0758E+07	9.3364E+04
		32-37	3.28E-03	7.1717E+06	2.3494E+04
		37-42	8.33E-04	7.1717E+06	5.9740E+03
		42-47	1.06E-04	7.1717E+06	7.6020E+02
		47-52	7.30E-05	7.1717E+06	5.2353E+02
		52-57	7.30E-05	1.0758E+07	7.8530E+02
		57-62	2.90E-05	1.4343E+07	4.1596E+02
		62-67	1.90E-05	7.1717E+06	1.3626E+02
		67-72	2.90E-06	1.0758E+07	3.1197E+01
		72-77	1.80E-06	2.1515E+07	3.8727E+01
		77-82	2.20E-06	3.2273E+07	7.1000E+01
		82-87	2.90E-05	1.4343E+07	4.1596E+02
		87-92	0.00E+00	0.0000E+00	0.0000E+00
		92-97	0.00E+00	0.0000E+00	0.0000E+00
		TOTAL			4.2152E+05

continued

Appendix A.7. (p. 3 of 7)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	5	2-7	6.49E-03	8.1962E+06	5.3169E+04
		7-12	3.73E-03	1.6392E+07	6.1160E+04
		12-17	3.57E-03	2.0490E+07	7.3110E+04
		17-22	8.71E-03	1.2294E+07	1.0705E+05
		22-27	9.89E-03	1.2294E+07	1.2164E+05
		27-32	7.94E-03	8.1962E+06	6.5045E+04
		32-37	3.05E-03	8.1962E+06	2.5015E+04
		37-42	6.97E-04	8.1962E+06	5.7127E+03
		42-47	1.76E-04	8.1962E+06	1.4425E+03
		47-52	8.00E-05	1.2294E+07	9.8354E+02
		52-57	4.30E-05	8.1962E+06	3.5244E+02
		57-62	5.80E-06	1.6392E+07	9.5076E+01
		62-67	1.50E-05	1.2294E+07	1.8441E+02
		67-72	6.90E-08	1.2294E+07	8.4831E-01
		72-77	1.10E-05	1.6392E+07	1.8032E+02
		77-82	6.60E-06	2.8687E+07	1.8933E+02
		82-87	7.60E-06	1.6392E+07	1.2458E+02
		87-92	0.00E+00	0.0000E+00	0.0000E+00
		92-97	0.00E+00	0.0000E+00	0.0000E+00
		TOTAL			5.1545E+05
1	6	2-7	1.56E-04	7.8236E+06	1.2205E+03
		7-12	1.33E-03	7.8236E+06	1.0382E+04
		12-17	3.37E-03	1.1735E+07	3.9525E+04
		17-22	9.55E-03	1.1735E+07	1.1210E+05
		22-27	1.08E-02	1.1735E+07	1.2651E+05
		27-32	9.83E-03	7.8236E+06	7.6906E+04
		32-37	3.63E-03	1.1735E+07	4.2588E+04
		37-42	9.20E-04	7.8236E+06	7.1977E+03
		42-47	1.44E-04	7.8236E+06	1.1266E+03
		47-52	4.30E-05	7.8236E+06	3.3642E+02
		52-57	1.40E-05	1.1735E+07	1.6430E+02
		57-62	6.10E-06	1.5647E+07	9.5448E+01
		62-67	5.10E-06	1.5647E+07	7.9801E+01
		67-72	1.10E-05	1.1735E+07	1.2909E+02
		72-77	3.10E-06	2.3471E+07	7.2760E+01
		77-82	1.90E-05	2.3471E+07	4.4595E+02
		82-87	8.10E-05	3.5206E+07	2.8517E+03
		87-92	0.00E+00	3.9118E+06	0.0000E+00
		92-97	0.00E+00	0.0000E+00	0.0000E+00
		TOTAL			4.2173E+05

continued

Area	Transect	Bottom Depth(m)	Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
2	1	2-7	4.54E-04	0.0000E+00	0.0000E+00
		7-12	4.58E-04	2.9096E+06	1.3326E+03
		12-17	1.69E-03	2.9096E+06	4.9055E+03
		17-22	2.08E-03	2.9096E+06	6.0577E+03
		22-27	1.86E-03	5.8191E+06	1.0800E+04
		27-32	9.10E-04	5.8191E+06	5.2954E+03
		32-37	6.18E-04	5.8191E+06	3.5962E+03
		37-42	1.94E-04	5.8191E+06	1.1289E+03
		42-47	8.80E-05	8.7287E+06	7.6813E+02
		47-52	1.40E-05	5.8191E+06	8.1468E+01
		52-57	2.90E-05	8.7287E+06	2.5313E+02
		57-62	1.90E-05	5.8191E+06	1.1056E+02
		62-67	4.00E-05	8.7287E+06	3.4915E+02
		67-72	2.70E-06	8.7287E+06	2.3567E+01
		72-77	2.20E-06	1.1638E+07	2.5604E+01
		77-82	4.30E-06	1.1638E+07	5.0045E+01
		82-87	3.20E-06	8.7287E+06	2.7932E+01
		87-92	0.00E+00	8.7287E+06	0.0000E+00
		92-97	0.00E+00	1.4548E+07	0.0000E+00
		TOTAL			3.4806E+04
2	2	2-7	4.39E-04	6.4761E+06	2.8430E+03
		7-12	1.12E-03	6.4761E+06	7.2403E+03
		12-17	2.57E-03	8.6348E+06	2.2226E+04
		17-22	4.25E-03	6.4761E+06	2.7549E+04
		22-27	4.33E-03	4.3174E+06	1.8690E+04
		27-32	2.53E-03	6.4761E+06	1.6391E+04
		32-37	9.84E-04	6.4761E+06	6.3725E+03
		37-42	6.09E-04	4.3174E+06	2.6293E+03
		42-47	5.50E-04	4.3174E+06	2.3746E+03
		47-52	1.46E-04	4.3174E+06	6.3034E+02
		52-57	2.90E-05	4.3174E+06	1.2521E+02
		57-62	4.10E-05	4.3174E+06	1.7701E+02
		62-67	2.10E-05	4.3174E+06	9.0666E+01
		67-72	1.60E-06	4.3174E+06	6.9079E+00
		72-77	2.00E-06	4.3174E+06	8.6348E+00
		77-82	8.20E-06	4.3174E+06	3.5403E+01
		82-87	9.80E-07	6.4761E+06	6.3466E+00
		87-92	0.00E+00	4.3174E+06	0.0000E+00
		92-97	1.00E-06	4.3174E+06	4.3174E+00
		TOTAL			1.0740E+05

continued

Appendix A.7. (p. 5 of 7)

Area	Transect	Bottom Depth(m)	Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
2	3	2-7	5.40E-05	2.0913E+06	1.1293E+02
		7-12	8.82E-04	6.2738E+06	5.5334E+03
		12-17	2.03E-03	6.2738E+06	1.2755E+04
		17-22	3.25E-03	4.1825E+06	1.3601E+04
		22-27	2.70E-03	8.3650E+06	2.2602E+04
		27-32	2.20E-03	8.3650E+06	1.8386E+04
		32-37	1.08E-03	8.3650E+06	8.9924E+03
		37-42	3.76E-04	8.3650E+06	3.1452E+03
		42-47	1.02E-04	8.3650E+06	8.5323E+02
		47-52	7.30E-05	1.0456E+07	7.6331E+02
		52-57	4.70E-05	1.4639E+07	6.8802E+02
		57-62	1.21E-04	1.0456E+07	1.2652E+03
		62-67	1.98E-04	1.0456E+07	2.0703E+03
		67-72	7.70E-06	1.0456E+07	8.0513E+01
		72-77	5.10E-06	1.2548E+07	6.3992E+01
		77-82	2.70E-06	6.2738E+06	1.6939E+01
		82-87	1.00E-05	4.1825E+06	4.1825E+01
		87-92	0.00E+00	4.1825E+06	0.0000E+00
		92-97	8.90E-06	4.1825E+06	3.7224E+01
		TOTAL			9.1009E+04
3	1	2-7	3.96E-03	0.0000E+00	0.0000E+00
		7-12	6.32E-04	0.0000E+00	0.0000E+00
		12-17	3.17E-04	0.0000E+00	0.0000E+00
		17-22	2.33E-04	4.5000E+06	1.0485E+03
		22-27	1.30E-04	4.5000E+06	5.8500E+02
		27-32	1.12E-03	2.2500E+07	2.5088E+04
		32-37	7.30E-05	2.7000E+07	1.9710E+03
		37-42	9.30E-05	1.8000E+07	1.6740E+03
		42-47	3.50E-05	2.2500E+07	7.8750E+02
		47-52	3.00E-05	2.2500E+07	6.7500E+02
		52-57	4.95E-04	9.0000E+06	4.4550E+03
		57-62	8.57E-04	9.0000E+06	7.7130E+03
		62-67	1.06E-03	4.5000E+06	4.7745E+03
		67-72	0.00E+00	0.0000E+00	0.0000E+00
		72-77	0.00E+00	0.0000E+00	0.0000E+00
		77-82	0.00E+00	0.0000E+00	0.0000E+00
		82-87	0.00E+00	0.0000E+00	0.0000E+00
		87-92	0.00E+00	0.0000E+00	0.0000E+00
		92-97	0.00E+00	0.0000E+00	0.0000E+00
		TOTAL			4.8771E+04

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
3	2	2-7	2.89E-03	0.0000E+00	0.0000E+00
		7-12	3.46E-04	0.0000E+00	0.0000E+00
		12-17	1.82E-04	0.0000E+00	0.0000E+00
		17-22	6.08E-04	8.1818E+06	4.9745E+03
		22-27	2.10E-04	1.2273E+07	2.5773E+03
		27-32	2.58E-04	1.2273E+07	3.1664E+03
		32-37	3.90E-05	1.2273E+07	4.7864E+02
		37-42	1.70E-05	8.1818E+06	1.3909E+02
		42-47	2.50E-05	8.1818E+06	2.0455E+02
		47-52	3.30E-06	8.1818E+06	2.7000E+01
		52-57	1.30E-06	8.1818E+06	1.0636E+01
		57-62	4.50E-07	8.1818E+06	3.6818E+00
		62-67	5.10E-06	8.1818E+06	4.1727E+01
		67-72	4.20E-07	8.1818E+06	3.4364E+00
		72-77	5.40E-08	8.1818E+06	4.4182E-01
		77-82	0.00E+00	8.1818E+06	0.0000E+00
		82-87	1.90E-08	8.1818E+06	1.5545E-01
		87-92	0.00E+00	8.1818E+06	0.0000E+00
		92-97	1.91E-04	1.2273E+07	2.3441E+03
		TOTAL			1.3972E+04
3	3	2-7	2.51E-03	0.0000E+00	0.0000E+00
		7-12	9.72E-04	2.3684E+06	2.3021E+03
		12-17	5.23E-04	2.3684E+06	1.2387E+03
		17-22	6.07E-04	2.3684E+06	1.4376E+03
		22-27	4.36E-04	4.7368E+06	2.0653E+03
		27-32	1.08E-04	4.7368E+06	5.1158E+02
		32-37	2.40E-05	4.7368E+06	1.1368E+02
		37-42	4.30E-05	7.1053E+06	3.0553E+02
		42-47	1.50E-05	7.1053E+06	1.0658E+02
		47-52	3.70E-06	4.7368E+06	1.7526E+01
		52-57	1.40E-05	4.7368E+06	6.6316E+01
		57-62	2.20E-05	4.7368E+06	1.0421E+02
		62-67	7.90E-06	4.7368E+06	3.7421E+01
		67-72	2.40E-06	9.4737E+06	2.2737E+01
		72-77	4.90E-06	1.6579E+07	8.1237E+01
		77-82	8.30E-06	1.6579E+07	1.3761E+02
		82-87	4.90E-06	1.4211E+07	6.9632E+01
		87-92	0.00E+00	1.1842E+07	0.0000E+00
		92-97	0.00E+00	1.1842E+07	0.0000E+00
		TOTAL			8.6177E+03

Appendix A.7. (p. 7 of 7)

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
3	4	2-7	2.95E-04	0.0000E+00	0.0000E+00
		7-12	4.99E-04	3.0000E+06	1.4970E+03
		12-17	6.40E-04	6.0000E+06	3.8400E+03
		17-22	1.32E-03	6.0000E+06	7.9140E+03
		22-27	7.59E-04	6.0000E+06	4.5540E+03
		27-32	2.95E-04	9.0000E+06	2.6550E+03
		32-37	7.70E-05	6.0000E+06	4.6200E+02
		37-42	3.80E-06	6.0000E+06	2.2800E+01
		42-47	1.41E-04	9.0000E+06	1.2690E+03
		47-52	5.20E-05	6.0000E+06	3.1200E+02
		52-57	1.60E-05	9.0000E+06	1.4400E+02
		57-62	1.10E-05	6.0000E+06	6.6000E+01
		62-67	1.30E-05	6.0000E+06	7.8000E+01
		67-72	9.20E-09	6.0000E+06	5.5200E-02
		72-77	1.60E-05	6.0000E+06	9.6000E+01
		77-82	3.20E-07	9.0000E+06	2.8800E+00
		82-87	1.00E-05	9.0000E+06	9.0000E+01
		87-92	0.00E+00	9.0000E+06	0.0000E+00
		92-97	1.13E-04	9.0000E+06	1.0170E+03
		TOTAL			2.4020E+04

Appendix A.8. Estimated number of fish not available to the hydroacoustic equipment because of bottom orientation in Kenai Lake, Alaska 2 October 1992.

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	1	2-7	1.1150E-02	5.1467E+06	5.7385E+04
		7-12	6.4520E-03	1.0293E+07	6.6413E+04
		12-17	5.5950E-03	1.5440E+07	8.6387E+04
		17-22	5.6810E-03	1.0293E+07	5.8476E+04
		22-27	3.2820E-03	1.0293E+07	3.3783E+04
		27-32	0.0000E+00	0.0000E+00	0.0000E+00
		32-37	0.0000E+00	0.0000E+00	0.0000E+00
		37-42	0.0000E+00	0.0000E+00	0.0000E+00
		42-47	0.0000E+00	0.0000E+00	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			3.0244E+05
1	2	2-7	3.7200E-04	5.1467E+06	1.9146E+03
		7-12	4.1560E-03	5.1467E+06	2.1390E+04
		12-17	2.5230E-03	1.0293E+07	2.5970E+04
		17-22	1.8000E-03	1.5440E+07	2.7792E+04
		22-27	1.0640E-03	1.0293E+07	1.0952E+04
		27-32	0.0000E+00	0.0000E+00	0.0000E+00
		32-37	0.0000E+00	0.0000E+00	0.0000E+00
		37-42	0.0000E+00	0.0000E+00	0.0000E+00
		42-47	0.0000E+00	0.0000E+00	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			8.8018E+04

continued

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	3	2-7	4.6000E-05	6.1760E+06	2.8410E+02
		7-12	5.4800E-04	6.1760E+06	3.3844E+03
		12-17	9.2400E-04	9.2640E+06	8.5599E+03
		17-22	5.8300E-04	6.1760E+06	3.6006E+03
		22-27	2.1790E-03	9.2640E+06	2.0186E+04
		27-32	1.4530E-03	9.2640E+06	1.3461E+04
		32-37	0.0000E+00	3.0880E+06	0.0000E+00
		37-42	0.0000E+00	0.0000E+00	0.0000E+00
		42-47	0.0000E+00	0.0000E+00	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			4.9476E+04
1	4	2-7	1.0100E-04	0.0000E+00	0.0000E+00
		7-12	2.8600E-04	2.2057E+06	6.3083E+02
		12-17	9.1500E-04	6.6171E+06	6.0547E+03
		17-22	8.1700E-04	4.4114E+06	3.6041E+03
		22-27	9.2500E-04	4.4114E+06	4.0806E+03
		27-32	7.3100E-04	6.6171E+06	4.8371E+03
		32-37	2.7300E-04	1.1029E+07	3.0108E+03
		37-42	0.0000E+00	4.4114E+06	0.0000E+00
		42-47	0.0000E+00	4.4114E+06	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			2.2218E+04

continued

Area	Transect	Bottom Depth(m)	Estimated Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	5	2-7	0.0000E+00	0.0000E+00	0.0000E+00
		7-12	7.9000E-04	1.9300E+06	1.5247E+03
		12-17	1.6590E-03	1.9300E+06	3.2019E+03
		17-22	1.0170E-03	3.8600E+06	3.9256E+03
		22-27	1.4780E-03	5.7900E+06	8.5576E+03
		27-32	6.9600E-04	5.7900E+06	4.0298E+03
		32-37	2.7100E-04	5.7900E+06	1.5691E+03
		37-42	7.9000E-07	9.6500E+06	7.6235E+00
		42-47	0.0000E+00	9.6500E+06	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			2.2816E+04
1	6	2-7	8.5000E-06	2.2057E+06	1.8749E+01
		7-12	1.5250E-03	2.2057E+06	3.3637E+03
		12-17	5.4900E-04	4.4114E+06	2.4219E+03
		17-22	8.3300E-04	4.4114E+06	3.6747E+03
		22-27	7.6400E-04	4.4114E+06	3.3703E+03
		27-32	3.5500E-04	8.8229E+06	3.1321E+03
		32-37	1.8000E-05	6.6171E+06	1.1911E+02
		37-42	0.0000E+00	8.8229E+06	0.0000E+00
		42-47	0.0000E+00	8.8229E+06	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			1.6101E+04

continued

Appendix A.8. (p. 4 of 4)

Area	Transect	Bottom Depth(m)	Fish Density (number/m^3)	Estimated Volume (m^3)	Estimated Number of Fish
1	7	2-7	7.2800E-04	0.0000E+00	0.0000E+00
		7-12	1.3300E-04	2.2057E+06	2.9336E+02
		12-17	1.5620E-03	2.2057E+06	3.4453E+03
		17-22	7.9100E-04	2.2057E+06	1.7447E+03
		22-27	5.0900E-04	4.4114E+06	2.2454E+03
		27-32	2.7100E-04	6.6171E+06	1.7932E+03
		32-37	5.3000E-05	1.1029E+07	5.8451E+02
		37-42	0.0000E+00	1.3234E+07	0.0000E+00
		42-47	0.0000E+00	1.3234E+07	0.0000E+00
		47-52	0.0000E+00	0.0000E+00	0.0000E+00
		52-57	0.0000E+00	0.0000E+00	0.0000E+00
		57-62	0.0000E+00	0.0000E+00	0.0000E+00
		62-67	0.0000E+00	0.0000E+00	0.0000E+00
		67-72	0.0000E+00	0.0000E+00	0.0000E+00
		72-77	0.0000E+00	0.0000E+00	0.0000E+00
		77-82	0.0000E+00	0.0000E+00	0.0000E+00
		82-87	0.0000E+00	0.0000E+00	0.0000E+00
		87-92	0.0000E+00	0.0000E+00	0.0000E+00
		92-97	0.0000E+00	0.0000E+00	0.0000E+00
		TOTAL			1.0107E+04